



# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# ACKNOWLEDGEMENTS

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massDOT
Massachusetts Department of Transportation



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# Executive Summary

***MassDOT launched the Cape Cod Canal Transportation Study ("the Study") to understand existing and future transportation conditions in the Cape Cod Canal area. The Study provides recommendations for improving multimodal connectivity and reliability across the Canal to protect quality of life for Cape Cod residents, workers, and visitors.***

## A FAMILIAR STORY: AGING INFRASTRUCTURE AND INCREASED TRAVEL DEMANDS

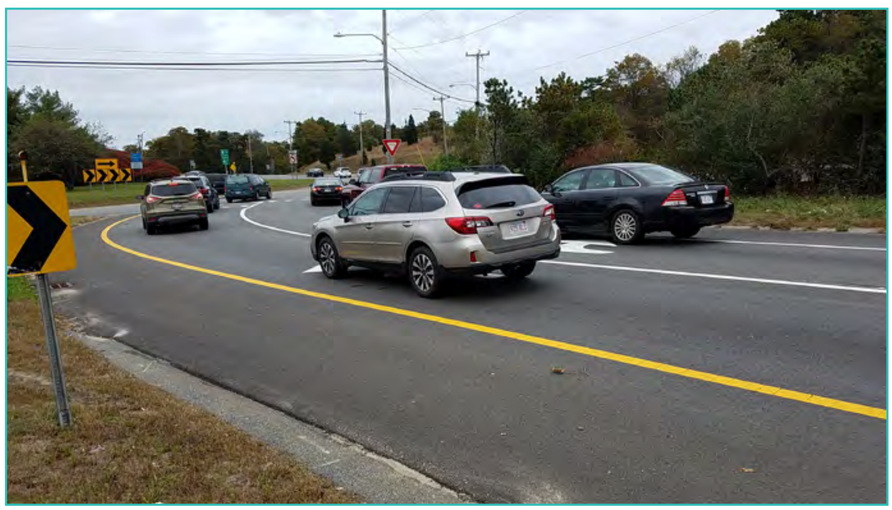
The seven-mile-long Cape Cod Canal was built in 1916 to shorten travel times and improve the safety of ships heading south from Boston and Plymouth. Mass-production of the automobile had only just begun, and roughly 20 years later (in 1935), the newly-constructed Bourne and Sagamore Bridges carried their first cars over the Canal to the delight and relief of Cape Cod's 26,000 residents.

Today, the Bourne and Sagamore Bridges continue to provide the only vehicular connections between the 15 communities and 215,000 residents on Cape Cod with the Massachusetts mainland. The lack of other connections, however, creates challenges. Cape

Cod and the Islands of Martha's Vineyard and Nantucket are major tourist destinations whose recreational activities create travel demands that soar during the summer.

Cape Cod residents and visitors must often contend with substantial traffic congestion during the summer tourist season. During the non-summer season, access over the Canal is frequently complicated by maintenance-related lane closures on the bridges. While these delays result from increased traffic demands created by an influx of visitors, the impacts of these delays impact visitors, year-round residents, and businesses alike by extending travel times, introducing and perpetuating safety concerns, and limiting access to destinations.

This study focuses on transportation issues in the Cape Cod Canal area. These issues include vehicle congestion and delay, incomplete and inaccessible pedestrian and bicycle facilities, and limited transit options. The impact of these issues extends to all of Cape Cod, Martha's Vineyard, and Nantucket. Ultimately, this study identifies a series of multimodal transportation improvements that satisfy study goals and objectives and reflect the study findings and public feedback.



*Traffic at the Bourne Rotary.*

The Cape Cod Canal, the Sagamore and Bourne Bridges, and the surrounding open space, is owned and operated by the U.S. Army Corps of Engineers (USACE). Identical in design, the Sagamore and Bourne Bridges are now more than 80 years old. They have exceeded their design life and require substantial regular maintenance to function reliably.

Furthermore, under today's engineering guidelines, the bridge design is substandard in several ways: travel-lane widths are too narrow, there are no roadway shoulders, and bicycle and pedestrian accommodations are minimal. At 12-inches, the granite curbing separating the roadway from the sidewalk is higher than is typical.

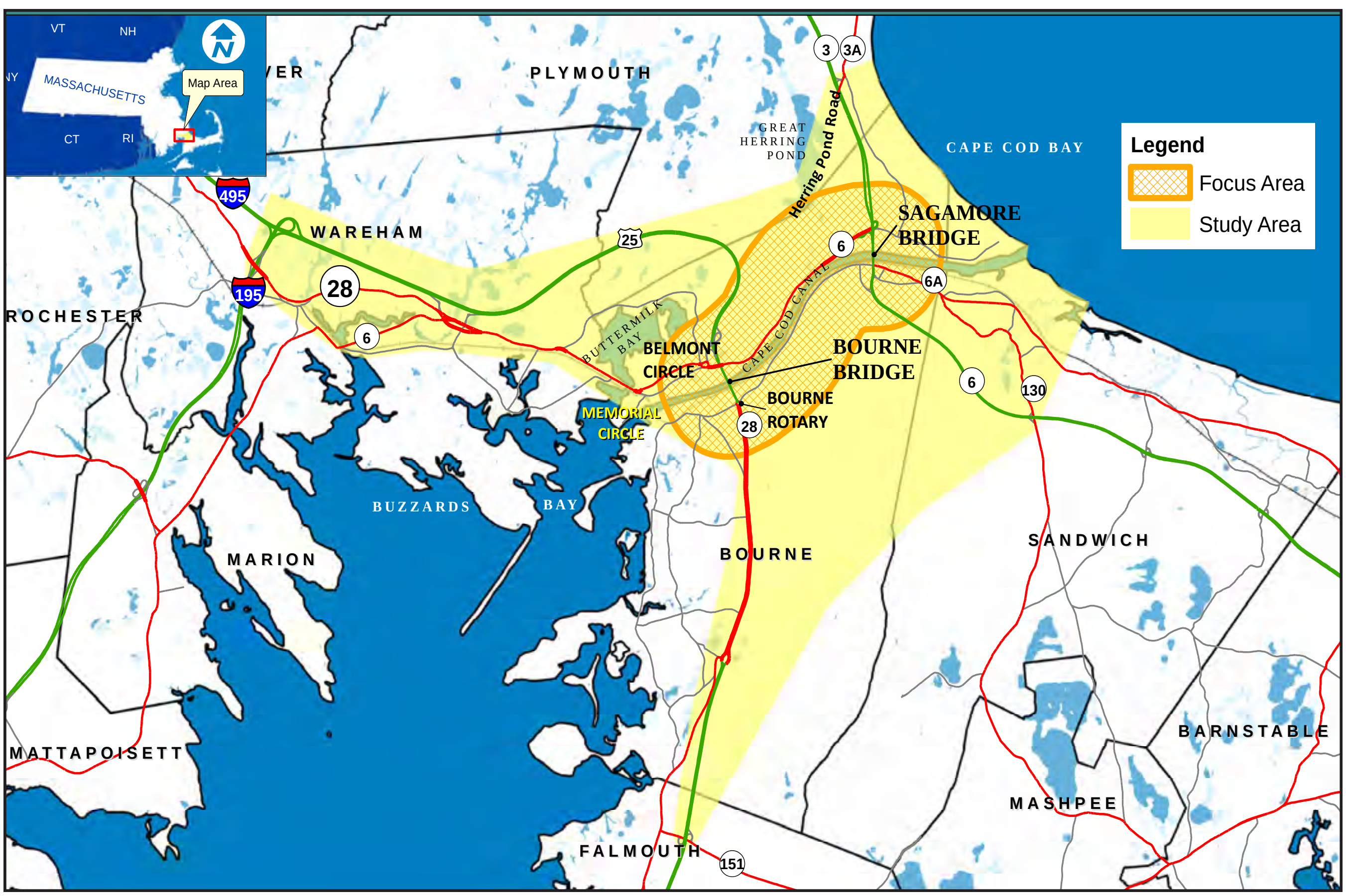
The USACE is currently preparing a 'Major Rehabilitation Evaluation Report' that will determine whether the USACE should continue to perform long-term maintenance on the bridges, or to replace them.

In addition to the challenges presented by two aging bridges, many Canal-area roads and intersections experience severe congestion during peak travel periods. Cape Cod also suffers from a lack of transportation options with limited bus, transit, and pedestrian/bicycle facilities. Furthermore, the condition, capacity, and lack of multimodal features of the Sagamore and Bourne Bridges contribute to Cape Cod's connectivity limitations.

## THE STUDY AREA

To gain a thorough understanding of the myriad issues and constraints subsumed in this study, information related to environmental resources, socio-economic data, and traffic was gathered for the "study area", which includes up to four miles on either side of the Canal (Exhibit ES-1). More detailed traffic data collection and analysis occurred within the study's "focus area," an area approximately one mile north and south of the Canal, where most proposed transportation improvements are anticipated to occur.

***Exhibit ES-1 Study Area / Focus Area***



## REPORT AND STUDY PROCESS OVERVIEW

The study, and ultimately this report, has followed a five-step process and framework:

**Step 1: Define the Study Goals, Objectives, and Evaluation Criteria**

In cooperation with the study Working Group, the study goals and objectives were established. Evaluation criteria were determined for study recommendations. Public engagement and participation, meeting MassDOT's Accessible Meeting Policy Directive, was encouraged. This allowed the community to contribute to the study in a meaningful way throughout the process.

**Step 2: Review & Evaluate Existing and Future Conditions**

Existing natural and social environmental resource conditions were documented. Multimodal traffic counts were conducted, and existing and future traffic conditions were analyzed. Key problem intersections in the focus area were identified for additional study. Transportation improvement constraints and opportunities were identified.

**Step 3: Develop a Range of Design Alternatives**

A range of conceptual design alternatives for roadway and other multimodal transportation improvements was developed based on future travel demand at key problem intersections in the focus area. Potential alternatives were developed to improve traffic mobility without overbuilding in a manner inconsistent with the character of Cape Cod.

**Step 4: Analyze Design Alternatives Based on Evaluation Criteria**

Traffic analysis of improvement alternatives at key problem intersections was developed. Each alternative's effectiveness in meeting the study's goals and objectives was evaluated and documented. The results of the traffic analysis was presented to the Working Group and public for feedback regarding which alternatives to advance to travel demand model analysis.

Regional travel demand model analysis used to evaluate the effectiveness of several transportation improvement groups improvements had been identified in Step 3. The travel demand model also estimated potential shifts or diversions in travel patterns in the study area that could cause unforeseen impacts in other locations.

**Step 5: Provide Recommendations**

In cooperation with the study Working Group, the multimodal transportation improvement alternatives that best advance the study goals and objectives were identified.

## STEP 1: DEFINE THE STUDY GOALS, OBJECTIVES, AND EVALUATION CRITERIA

The study's goals and objectives were developed by MassDOT in cooperation with the study Working Group; all recommended transportation improvements will advance the study's goals and objectives.

***The Working Group is made up of representatives from:***

- ***Municipal departments and locally elected officials***
- ***State agencies & elected officials***
- ***Federal agencies***
- ***Metropolitan planning organizations***
- ***Chambers of commerce***
- ***Key businesses***
- ***Other interested parties***

### Goals

- Improve transportation mobility and accessibility in the Cape Cod Canal area and provide reliable year-round connectivity over the Canal and between the Sagamore and Bourne Bridges.

### Objectives

- Improve multimodal connectivity and mobility across the Canal to avoid degrading quality of life on the Cape.
- Ensure that cross-canal connectivity does not become a barrier to reliable intra community travel within Bourne and Sandwich.
- Create reliable multimodal connections across the Canal to ensure public safety in the event of an emergency evacuation of portions of the Cape and accommodate first responders trying to reach the Cape.

***As guided by the study's Public Involvement Plan, the community played a key role in shaping the study framework and providing detailed and comprehensive comments to build agreement and support for the study recommendations. Four public meetings and 11 Working Group meetings shaped the framework of the entire study.***

***The accessible public record is available on the project website:*** https://www.mass.gov/cape-cod-canal-transportation-study

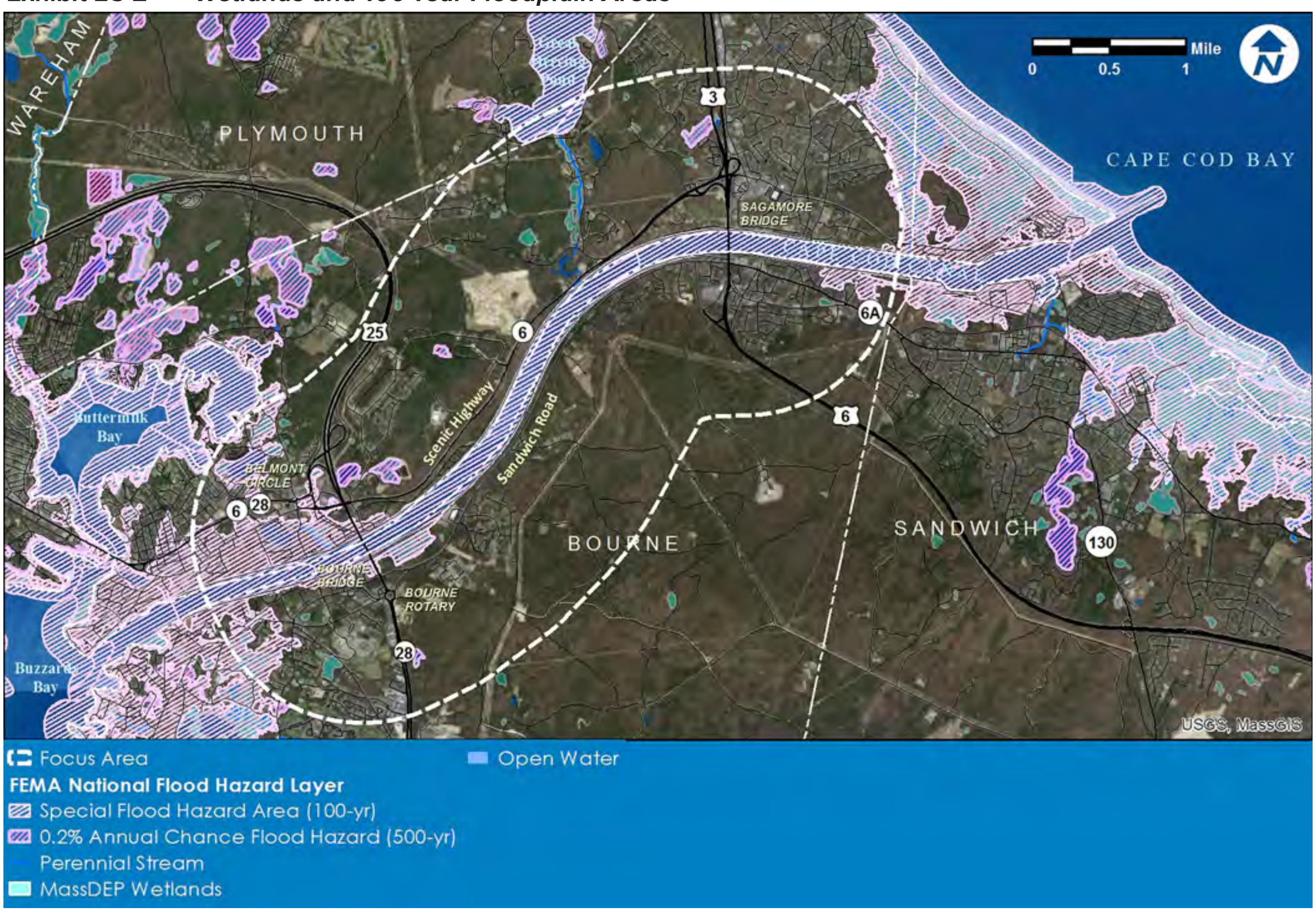
## Evaluation Criteria

The Cape Cod Canal study area is home to a variety of environments, land uses, and socio-economic conditions. To advance the study goals and objectives, evaluation criteria were determined to help guide the design and decision-making process. With input from the Working Group, MassDOT identified criteria that could help analyze the study area and inform potential transportation improvements. The following six categories were chosen:

- Transportation
- Environment
- Community
- Land Use / Economic Development
- Safety
- Feasibility

As appropriate, the study team derived individual criteria for each transportation mode directly from either existing data or analytical techniques used in this study. These criteria—both quantifiable and qualitative measures of effectiveness—helped

***Exhibit ES-2 Wetlands and 100-Year Floodplain Areas***



identify the solutions that best matched the study's goals and objectives.

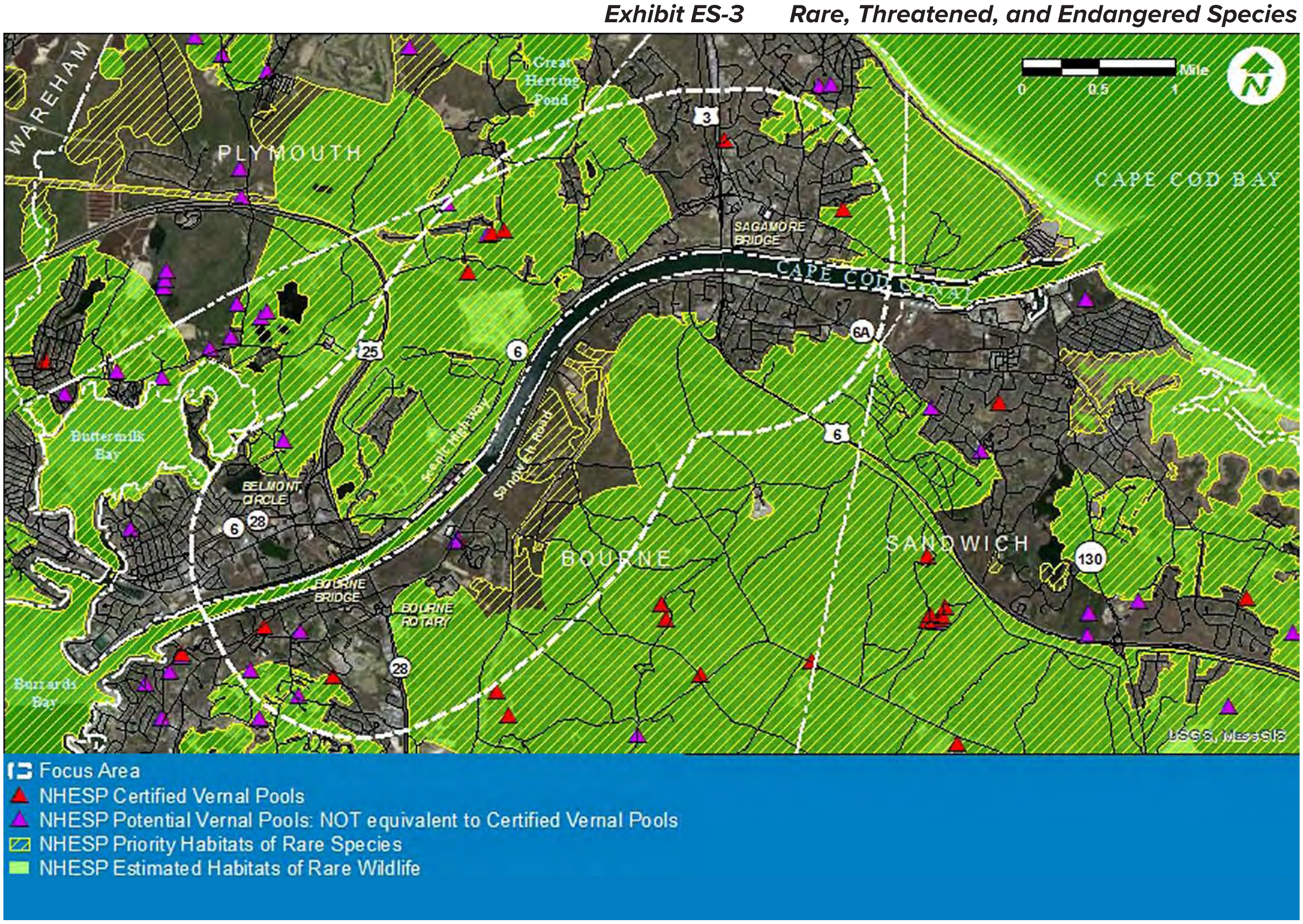
## STEP 2: REVIEW & EVALUATE EXISTING AND FUTURE CONDITIONS

Data about existing conditions in the study area – including roadway and multimodal facilities, natural and social environmental resources, and socio-economic conditions – informed the design constraints and provided a basis for the evaluation criteria. Next, existing and future traffic volumes in the study area were modeled to create a future (2040) 'no build' alternative which serves as the baseline for the comparison of future transportation improvements.

### Natural Environmental Resources

The study area features an abundance of natural environmental resources, particularly coastal and inland wetlands north and south of the Canal (Exhibit ES-2). Project area wetlands, floodplain, and waterbodies such as the Canal, Herring Pond, and Buttermilk Bay are critical for supporting recreation, fishing, shellfishing, wildlife habitat, and flood control.

***Exhibit ES-3 Rare, Threatened, and Endangered Species***



Flood hazard areas are identified, in roughly the same areas occupied by wetlands, both north and south of the Canal. Outside of the wetlands, a 100-year floodplain extends north of the Canal beyond Main Street to the Buzzards Bay Bypass.

Rare species habitat is prevalent throughout the study area, particularly within Joint Base Cape Cod (JBCC) and the Shawme-Crowell State Forest (Exhibit ES-3). The rare species include a wide variety of turtles, reptiles, birds, butterflies, moths, mussels, and plants. Numerous certified and potential vernal pools also exist throughout the study area.

The study area features two Areas of Critical Environmental Concern (ACEC), the Bourne Back River and the Herring River ACECs. Aquifers on Cape Cod are a particularly sensitive resource as they are part of a designated drinking water sole source aquifer.

### *Upper Cape Water Supply Reserve*

The Upper Cape Water Supply Reserve includes the northern 15,000 acres of the JBCC. The Massachusetts Legislature created the Reserve through Chapter 47 of the Acts of 2002. Owned by the Commonwealth, the Reserve serves two purposes:

1. New England's largest military training center: provides facilities for soldiers—from the Massachusetts Army National Guard and numerous other military branches—to practice maneuvering exercises and using the small arms ranges.

2. Drinking water and wildlife protection area: the largest piece of undeveloped land on Cape Cod which serves as a drinking water source for Upper Cape Cod and is home to 37 state-listed species living in a variety of habitats throughout the base.

## Social Environmental Resources

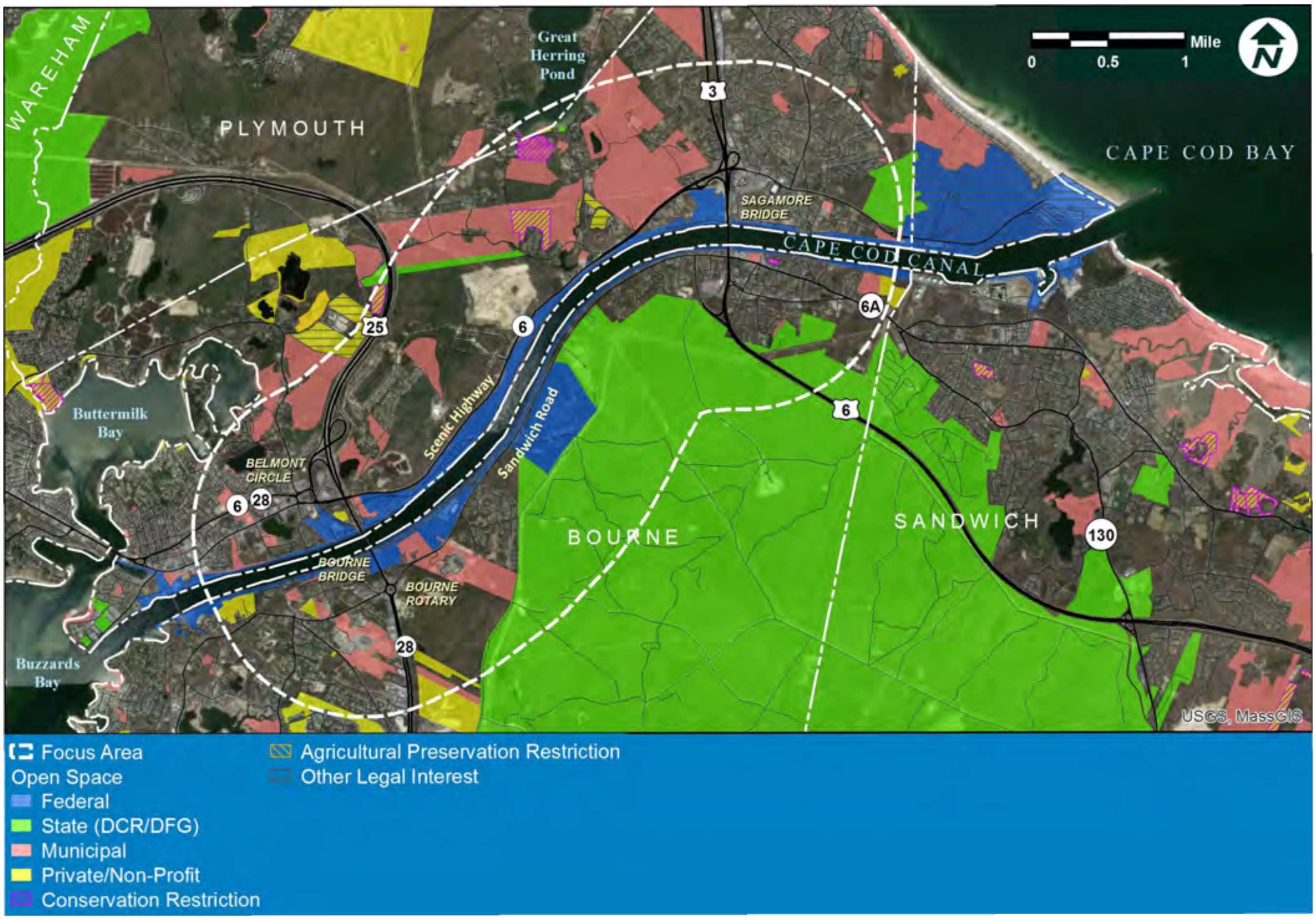
The study area, including Bourne, Plymouth, Sandwich, and Wareham, features numerous social environmental resources such as historic resources and open space. Historic sites include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville Town Hall Square, and Spring Hill National Historic Districts in Sandwich. Several public buildings in Bourne are individually listed on the National Register of Historic Places including Bourne High School, Jonathon Bourne Public Library, and Bourne Town Hall.

There are many publicly- and privately-owned parcels which are protected as open space (Exhibit ES-4). These properties serve a wide variety of purposes, including watershed protection, wildlife

habitat, conservation, recreation, public beaches, marinas, and camping. Open space properties in the study area include the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

While these natural and social environmental resources contribute to the appeal of Cape Cod, they also represent a constraint when developing alternatives for future transportation improvements.

***Exhibit ES-4 Protected Open Space***




### *Utilities*

Important utility corridors cross the study area, including an electrical utility corridor which transmits electricity from the Canal Generating Plant in Sandwich across the Canal and on to Cape Cod customers. Natural gas enters Cape Cod through a pipe network attached to the Canal bridges. Natural gas compressor stations are located close to both the Sagamore and Bourne Bridges.

These electrical transmission towers, gas lines, and compressor stations represent a substantial constraint when considering future work on the bridges.

### *Socio-Economic Conditions and Public Health*

Socio-economic conditions in Barnstable County (Cape Cod) are in transition. After several decades of rapid population and employment growth, the county is losing population (Table ES-1). Demographically speaking, Cape Cod is seeing a higher percentage of senior citizens alongside a lower percentage of working adults and school-age children. The unemployment rate in Barnstable County is similar to the state rate but fluctuates widely during the year, with a lower rate during the summer tourist season and a higher rate during the off season.

Any discussion of Barnstable County's population must acknowledge its seasonality. During the summer tourist season, the population of the county nearly doubles, increasing by approximately 200,000 people, due to the influx of seasonal residents, employees, and visitors. This substantial growth in the summertime population (with related increases in vehicle trips) places tremendous pressure on the transportation system in the Cape Cod Canal area.

Commuting is also an important issue in Barnstable County. Nearly 90% of workers use private automobiles to commute, and nearly 34,000 commuters cross one of the Canal bridges each work day, including more than 32% of workers in Bourne and 19% of workers in Sandwich.

*Table ES-1 Historical Population Change in Barnstable County*

| | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| Population | 70,286 | 96,656 | 147,925 | 186,605 | 222,230 | 215,888 | 213,444 | 213,413 |
| Percent (%) Change from Previous Period | | 37.52 | 53.04 | 26.15 | 19.09 | -2.85 | -1.13 | -0.01 |

*Source: US Census Bureau*

## Existing Transportation Network

### *Study Area Roadways*

The following sections describe the main highways corridors and other roadways in the study area (Exhibit ES-5), including:

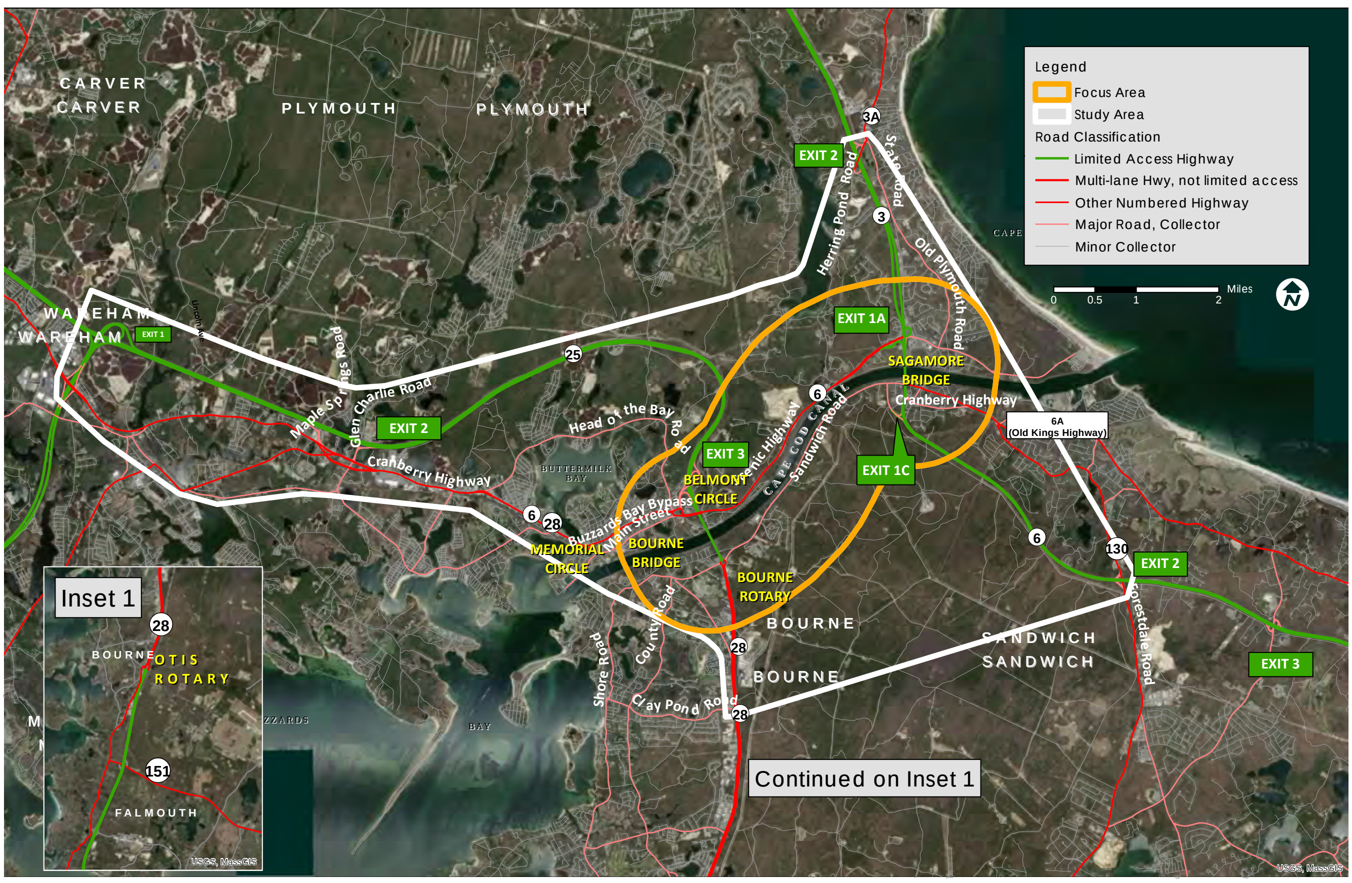
- Route 3/Sagamore Bridge/Route 6 corridor along the eastern side of the study area.
- Route 25/Bourne Bridge/Route 28 corridor along the western side of the study area.

These highways are all under MassDOT jurisdiction while the Canal bridges are owned by the USACE. The Sagamore and

Bourne bridges provide the only roadway access over the Canal to Cape Cod. The cross section of both bridges includes two 10-foot travel lanes in each direction with no roadway shoulder. A single 5-foot wide sidewalk is present on each bridge. The sidewalk is separated from the roadway by a 12-inch high granite curb.

Approaching the Sagamore Bridge on Route 3 southbound, vehicles pass through the "Sagamore Flyover" (Exit 1A – the interchange of Route 3 with Route 6/Scenic Highway). Coming from the north, one of the two Route 3 southbound travel lanes is dropped to allow travelers from Scenic Highway to merge onto Route 3 at Exit 1A, where the second travel lane is reinstated. This lane-drop on Route 3 southbound was a required – but less desirable – design feature of the 2006 reconstruction of the Sagamore Rotary as a highway interchange.

***Exhibit ES-5 Major Roadways in the Study Area***




Two principal arterial roadways in Bourne provide east-west access between the two Canal bridges:

_Route 6 (Scenic Highway)_

North of the Canal, Scenic Highway extends approximately 3.5 miles from Route 3 at the Sagamore Flyover in the east to Belmont Circle in the west.

*Sandwich Road*

South of the Canal, Sandwich Road extends approximately 4.7 miles from the Route 6A/Route 130 intersection in the east to the Sandwich Road/Trowbridge Road/County Road intersection in the west.

Other notable roadways in the study area include:

*Route 6A (Old King's Highway)*

Owned by the towns of Bourne and Sandwich, Route 6A extends approximately 1.3 miles from the Route 130/Sandwich Road intersection in Bourne to Tupper Road in Sandwich.

*Route 130*

Owned by the town of Sandwich, Route 130 extends approximately 2.9 miles from the Route 6A/Sandwich Road intersection to Route 6 at Exit 2 in Sandwich.

*Route 151*

Owned by the towns of Falmouth and Mashpee, Route 151 extends approximately 6.6 miles from the Route 28/Great Neck Road intersection in Mashpee east to the Otis Rotary in Falmouth. A 10 foot wide bike trail runs alongside a portion of the north side of Route 151. The trail extends 0.75 miles from Old Barnstable Road to Job's Fishing Road.

### Gateway Intersections

Three major intersections in the focus area ('gateway intersections') provide access to the Sagamore or Bourne Bridges and between the Route 3 - Route 6 corridor and the Route 25 - Route 28 corridor (Exhibit ES-5). These gateway intersections are:

*Belmont Circle*

This traffic circle is north of the Cape Cod Canal and immediately west of the Route 25 approach to the Bourne Bridge. The roadway approaches to Belmont Circle are Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the ramps to Route 25. The entrance ramp to Route 25 eastbound leads directly to the Bourne Bridge.

*Bourne Rotary*

The Bourne Rotary is located immediately south of the Bourne Bridge. The roadway approaches to the Bourne Rotary include

*Top: Belmont Circle, Bourne*
*Bottom: Bourne Rotary, Bourne*

Route 28 (on both the north and south sides of the Rotary), Trowbridge Road, and the Bourne Rotary Connector. A five-foot wide sidewalk exists on the west side of the Bourne Bridge. In 2017, MassDOT extended this sidewalk to the south around the front of the State Police barracks to Veterans Way.

*Route 6 Exit 1C Interchange*

This interchange includes westbound-only exit- and entrance-ramps to and from Cranberry Highway in Bourne. The highway ramps are immediately south of the Sagamore Bridge. The Christmas Tree Shops retail store is adjacent to the Exit 1C entrance ramp. At approximately 200 feet, these exit- and entrance-ramps are substandard in length. MassDOT Highway Design standards recommend 600-foot exit ramps and 1,000-foot entrance ramps.

## Pedestrian Facilities

Pedestrian facilities in the study area include sidewalks and the Cape Cod Canal service roads (bike paths). Sidewalks are generally present in more densely developed residential and commercial areas but absent elsewhere. Many roads in the study area are narrow (20–22 feet) and lack sidewalks, presenting difficulties for pedestrians, particularly the elderly or those with disabilities. Both the Sagamore and Bourne bridges provide a single, narrow sidewalk, but several of the approach roadways to the bridges lack accessible sidewalk connections.

*Bicyclists on the Canal bike path road.*

## Bicycle Facilities

Bicycle facilities in the study area include the Cape Cod Canal service roads (bike paths). The seven mile long paths run along both the north and south sides of the Canal. While there are several accessible connections to the Canal path from the local roadway network or parking lots, there are also notable areas that lack an accessible connection to the Canal path, which is required by the American's with Disabilities Act of 1990 (ADA).

There are gaps in the sidewalk system at the approaches to both bridges which makes it difficult for pedestrians or bicyclists to cross the Canal safely and comfortably. Sidewalks do not exist to connect the south end of the Sagamore Bridge to either Cranberry Highway or Sandwich Road. At the north end of the Bourne Bridge, a lack of sidewalks limit pedestrian access to Belmont Circle.

## Bus Service

Bus service on the Cape includes:

- Daily services via the **Cape Cod Regional Transit Authority (CCRTA)**, which includes:
  - Six year-round fixed-route services covering every town on Cape Cod (Sealine, H2O Hyannis-Orleans (H2O Line), FLEX, Barnstable Villager, Sandwich Line, and Bourne Run)
  - Seasonal fixed-route services (WOOSH Trolley, the Hyannis Area Trolley, and the Provincetown/North Truro Shuttle)
  - Demand-response services (Dial-A-Ride Transportation (DART), ADA paratransit services, and Boston Hospital Transportation)
- Privately-owned Peter **Pan Bus Line**, providing weekend service between Cape Cod and Boston, with increased frequency on weekdays and during the summer.
- Privately-owned **Plymouth and Brockton Bus Line**, running four bus routes between Boston and Provincetown 16 times a day from Hyannis to Boston's Logan International Airport via Barnstable, Sagamore, Plymouth, Rockland, and Boston.

## Rail Service

The MBTA provides summer weekend service to Cape Cod on the **Cape Flyer**. The Cape Flyer is a service that runs from South Station in Boston to the Hyannis Transportation Center on the Middleborough/Lakeville commuter rail line.

## Ferry Service

The **Steamship Authority (SSA)** operates year-round service and licenses private ferry operators to provide year round and seasonal water transport from the mainland to the islands. Ferries run via terminals between:

- Woods Hole and Nantucket/Martha's Vineyard
- Hyannis and Nantucket/Martha's Vineyard
- Boston and Provincetown's MacMillan Pier

*Top: Cape Flyer traveling over the Cape Cod Canal*
*Source: Debee Tlumacki for the Boston Globe*

*Bottom: The Steamship Authority terminal at Woods Hole*

## Airline Service

The Barnstable Municipal Airport serves flights by two major airlines:


Barnstable Municipal Airport

- **Cape Air** flies from Hyannis to Nantucket and Boston year-round, providing up to 12 round-trip flights a day. From May through October, the airline also flies from Hyannis to Martha's Vineyard
- **JetBlue Airlines** flies one round trip each day between New York City and Hyannis, seasonally.

## Park & Ride Lots

Three Park & Ride lots in (or near) the study area offer commuters and others the ability to carpool or use transit services on Cape Cod. These are:

- The Route 25 eastbound off-ramp at **Exit 2 in Wareham** (120 spaces).
- The **Sagamore Lot**, located north of the Cape Cod Canal at the southeast corner of the Route 3/Route 6 (Scenic Highway) interchange in Bourne (377 spaces). This lot is often at or near capacity year-round.
- A Park & Ride lot in **Barnstable** (just outside of the study area), located at Route 6 Exit 6 in (365 spaces).

## Traffic Conditions

To understand the existing traffic conditions throughout the study area, traffic data were collected using methods that include Automatic Traffic Recorders (ATRs), Turning Movement Counts (TMCs), and BlueTOAD™ origin-destination study. Traffic conditions were evaluated using a variety of traffic analysis software including the Highway Capacity Manual Software (HCS), Synchro™ Version 8, VISSIM™, and SIDRA™ 5.1. These traffic analysis techniques are accepted by the Federal Highway Administration (FHWA) and state Departments of Transportation nationwide, including MassDOT.

Based on the existing traffic, future travel demands were projected based on socio-economic factors that lead to changes in traffic volumes, including daily commuting trips to work and school combined with non-commuting trips related to daily shopping, recreation, and other local destinations. As a major

tourist destination, visitor travel to Cape Cod can contribute approximately 35% more vehicles on the Canal bridges during the summer compared to the non-summer.

Travel demands were forecast for the future (2040) no-build traffic conditions in the study area. Highway system improvements are typically designed to satisfy traffic demands forecast for 25 years in the future. As the traffic analysis for this study began in 2015, the year 2040 was selected as the design year. This analysis assumes that no substantial transportation improvements will be made in the study area between now and 2040, such as the construction of additional travel lanes, as well as new or reconstructed interchanges, intersections, or multimodal facilities. This 'no-build' alternative serves as the baseline for the comparison of future transportation improvements.

Traffic data collection and analysis methods:

*BlueTOAD™ Units.*


- **Automatic Traffic Recorders (ATRs)** – 57 locations – ATRs use pneumatic tubes placed across a roadway that record the number and type of all vehicles that pass over them.
- **Turning Movement Counts (TMCs)** – 37 locations – TMCs for vehicles were conducted by hand counts. Pedestrian and bicycle traffic were also counted.
- **BlueTOAD™** origin-destination study – 22 locations – A BlueTOAD™ unit performs detailed origin-destination studies by detecting the unique Bluetooth number of phones, navigation, and other GPS-based devices as they enter and exit a study area.
- **Highway Capacity Manual Software (HCS)** – 50 locations – HCS uses the Highway Capacity Manual (HCM) to calculate levels of service (LOS) and other measures of effectiveness of roadway operations for major highways.
- **Traffic analyzation and simulation software** – including Synchro™ v.8, SimTraffic, VISSIM™, and SIDRA™ 5.1 – assessed the efficiency of five signalized and 17 unsignalized intersections in the study area as well as the operations at Belmont Circle and Bourne Rotary.
- **Crash data** - crash data was collected for the years 2012-2014 (the most recent three-year period available at the time data was collected) from all study area intersections analyzed for LOS. These data were used to create diagrams that portray crashes by type and frequency. Analysis of these diagrams contributes to an understanding of why crashes may be occurring at certain locations.

Data derived from the traffic collection included average daily traffic (ADT), peak-hour volumes, and the turning movements of vehicles in the study area. Traffic operations and crash data were collected and analyzed.

### *Traffic Volumes*

The highest existing and future daily and peak-hour traffic volumes in the study area occur at the following locations:

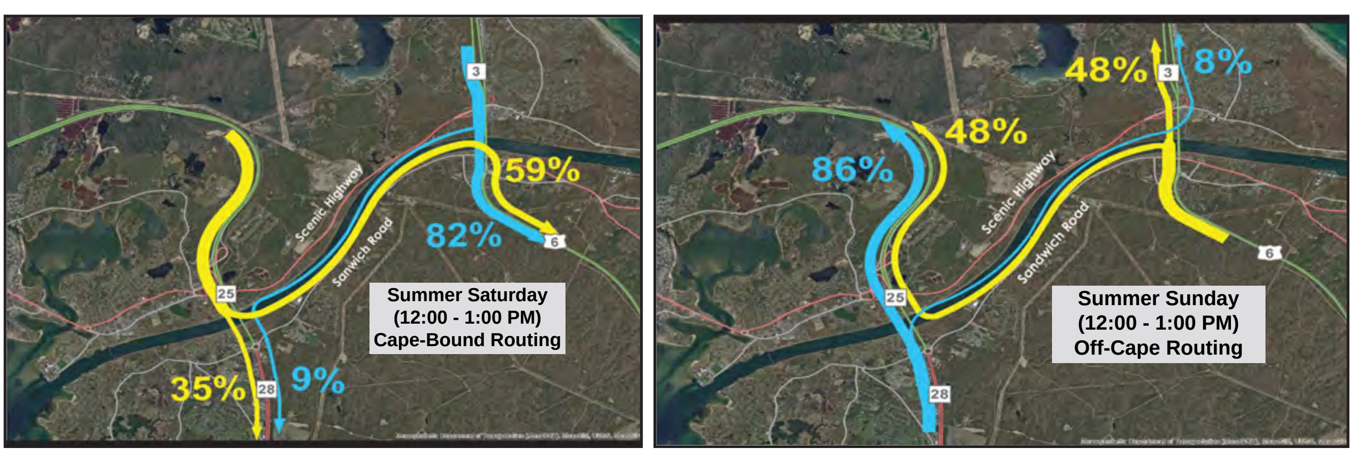
- Major bridges (Sagamore and Bourne Bridges)
- Major highways (Routes 3, 6, 25, 28, and 130)
- Arterial roadways (Scenic Highway, Sandwich Road, and Main Street in Bourne).

There are substantial seasonal differences in traffic volumes in the study area because Cape Cod is a major summer tourist destination. For example, daily traffic volumes on the Bourne and Sagamore Bridge are 49% and 59% higher in the summer compared to non-summer periods. The Sagamore Bridge generally has higher traffic volumes than the Bourne Bridge.

### *Travel Patterns*

A seven-day BlueTOAD™ origin-destination study highlighted a substantial amount of travel moving between the Route 3/Route 6 corridor and the Route 25/Route 28 corridor during all periods of the year. During summer Saturdays when visitors are traveling to Cape Cod, 59% of vehicles on Route 25 exit the highway at Belmont Circle and travel east on Scenic Highway to Route 6 (Exhibit ES-6). Similarly, on summer Sundays when visitors are leaving Cape Cod, 48% of vehicles exit Route 3 at the Sagamore interchange and travel west on Scenic Highway to Route 25, via Belmont Circle. These movements put tremendous pressure on the gateway intersections and lead to high levels of congestion during the peak hours.

***Exhibit ES-6 Routing of Traffic Between Highway Corridors***



### *Existing and Future No-Build Traffic Conditions*

Traffic conditions along highways and at intersections in the study area, particularly at the gateway intersections in the immediate area of the Canal bridges, often suffer from severe congestion and delay during peak periods. Several intersections, particularly Belmont Circle and Bourne Rotary, have a history of high crash rates.

Traffic volumes in the study area are forecast to increase approximately 30% in the summer period and 26% in the non-summer period between 2014 and 2040. This growth in traffic volumes will not be uniform throughout the study area; some locations will experience greater rates of growth than others.

Under the future (2040) no-build condition, locations forecast to experience the greatest increase in traffic volumes include the Sagamore Bridge and other roadways in the immediate area of the bridge such as Route 3 (between Exits 1A & 2), Route 6 (between Exits 1 & 2), the Mid-Cape Connector, and State Road. Other areas of notable forecast traffic increases include Trowbridge Road, Route 28 (south of the Bourne Rotary),

*Table ES-2 Growth in Average Daily Traffic (ADT) at Key Locations 2014 - 2040*

| ATR COUNTING STATIONS | EXISTING (2014) | | FUTURE (2040) | | PROJECTED GROWTH | |
|---|---|---|---|---|---|---|
| | SUMMER ADT[1] | NON-SUMMER ADT[1] | SUMMER ADT[1] | NON-SUMMER ADT[1] | SUMMER ADT[1] | NON-SUMMER ADT[1] |
| Bourne Bridge | 56,500 | 38,000 | 61,600 | 45,200 | 9% | 19% |
| Sagamore Bridge | 65,900 | 41,400 | 93,300 | 59,600 | 42% | 44% |
| Route 3 between Exits 1A and 2 | 51,600 | 29,900 | 72,400 | 51,800 | 40% | 73% |
| Route 6 between Exits 1 and 2 | 72,300 | 39,600 | 90,600 | 51,800 | 25% | 31% |
| Route 25 West of Exit 2 | 62,900 | 42,900 | 78,900 | 56,800 | 25% | 32% |
| Route 25 East of Exit 2 | 24,500 | 16,900 | 26,200 | 19,700 | 7% | 17% |
| Route 6 (Scenic Hwy) East of Nightingale Rd | 33,600 | 21,000 | 36,200 | 25,400 | 8% | 21% |
| Sandwich Rd East of Bourne Rotary Connector | 30,800 | 22,600 | 33,400 | 28,100 | 8% | 24% |
| Adams St South of Sandwich Rd | 7,600 | 7,600 | 11,800 | 13,900 | 55% | 83% |
| Buzzards Bay Bypass | 7,900 | 6,000 | 8,800 | 6,000 | 11% | 0% |
| Main St West of Perry Ave | 25,600 | 11,900 | 28,500 | 12,120 | 11% | 2% |
| Trowbridge Rd West of Veterans Way | 7,300 | 6,300 | 11,500 | 9,900 | 58% | 57% |
| Route 28 South of Bourne Rotary | 42,500 | 34,800 | 49,000 | 40,100 | 15% | 15% |
| Route 130 North of Route 6 | 12,200 | 9,300 | 12,500 | 13,200 | 2% | 42% |
| Route 6 between Exit 2 and 3 | 56,400 | 41,600 | 67,000 | 56,000 | 19% | 35% |
| Mid-Cape Connector South of Sandwich Rd | 19,100 | 15,300 | 28,500 | 18,100 | 49% | 18% |
| Route 6 East of Exit 3 | 57,000 | 44,900 | 70,900 | 53,400 | 24% | 19% |
| State Rd North of Ramp to Route 3 NB | 5,700 | 4,700 | 8,200 | 6,200 | 44% | 32% |
| Route 6A East of Cranberry Hwy | 12,400 | 7,500 | 15,100 | 8,300 | 22% | 11% |
| Route 3 between Exits 2 and 3 | 44,600 | 37,400 | 60,000 | 50,300 | 35% | 35% |

[1]*Average Daily Traffic (ADT)*

and Route 6 (between Exits 2 and 3). Table ES-2 shows that traffic volumes are generally forecast to increase more in the non-summer period than in the summer period.

Currently, the level of service (LOS) along the highways in the study area during peak periods are within the LOS A to LOS C range. In the future, traffic operations are forecast to degrade, with substantially more freeway and interchange locations operating at less acceptable levels (LOS D/E) during the summer periods (compared to the existing condition), particularly at the Bourne and Sagamore Bridges and adjacent interchanges.

The roads connecting the bridge approaches – Scenic Highway north of the Canal and Sandwich Road south of the Canal – also experience high traffic volumes and congestion. This is the result of high traffic volumes within the focus area (not just travel through the focus area) and vehicles traveling between the Route 25/Route 28 corridor and the Route 3/Route 6 corridor. This congestion is exacerbated by the inadequate capacity and sub-standard design of the intersections at the bridge approaches, especially gateway intersections at Belmont Circle, Bourne Rotary, and the Route 6 Exit 1C interchange south of the Sagamore Bridge. These intersections and several others along Sandwich Road and Scenic Highway currently experience severe congestion (LOS E/F) during both the summer and non-summer peak periods.

***Future No-Build traffic conditions were analyzed for the year 2040. Projecting future travel demand requires an understanding of the socio-economic factors that lead to changes in traffic volumes. The primary contributors to traffic volumes in most locations are the daily commuting trips to work and school combined with non-commuting trips related to daily shopping, recreation, and other local destinations. For this study, forecast visitor trips are also included.***

### *High-Crash Locations*

Crash data was collected for the years 2012–2014 (the most recent three-year period available at the time data was collected) from all study area intersections analyzed for LOS. Eight locations within the study area rank as HSIP high-crash locations (Exhibit ES-7). The locations in the study area with the highest crash rates include Belmont Circle, Bourne Rotary, and the intersections of Route 6A at Route 130 and Scenic Highway at Meetinghouse Lane.

*Exhibit ES-7   Problem Intersections in the Study Area*

Table ES-3 Future (2040) Year-Round Problem Intersections

| LOCATION NO. ON EXHIBIT ES-7 | LOCATION | TOWN | HIGH CRASH CLUSTER[1] | LOS E OR F (2040) |
|---|---|---|---|---|
| 10 | Scenic Highway/Meetinghouse Lane at Canal Street/State Road | Bourne | Yes | Yes |
| 5, 6 | Sandwich Road at Bourne Rotary Connector/High School Drive[2] | Bourne | Yes | Yes |
| 8 | Route 6A (Sandwich Road) at Cranberry Highway | Bourne | No | Yes |
| 11 | Route 130 at Cotuit Road | Sandwich | Yes | Yes |
| 2, 3 | Belmont Circle and Scenic Highway at Nightingale Pond Road[2] | Bourne | Yes | Yes |
| 4 | Bourne Rotary[3] | Bourne | Yes | Yes |
| 9 | Route 6A/Route 130/Tupper Road[4] | Sandwich | Yes | No |
| N/A | Route 6 Exit 1C Relocation[5] | Bourne | No | No |

*[1]High crash locations identified by MassDOT for the 2011-2013 or 2012-2014 periods.*
*[2]Locations combined due to their proximity.*
*[3]Combined with Sandwich Road at Bourne Rotary Connector intersection.*
*[4]To be combined with Route 6 Exit 1C Relocation.*
*[5]Advanced to Alternatives Development due to substandard design.*

## Issues, Constraints, and Opportunities

Based on the data collected regarding existing natural, cultural, and environmental resources, socio-economic and demographic data, and the traffic study, the following issues, constraints, and opportunities in the study area were identified.

Issues:

- Severe congestion at bridge approaches and gateway intersections.
- High crash rates at multiple intersections in study area.
- Balancing visitor and resident needs.
- Economic expansion hampered by low population growth and aging population.
- Lack of bicycle and pedestrian accommodation.

Constraints:

- Extensive areas of sensitive natural and social environmental resources.
- Existing utility corridors.
- Developed residential and commercial areas.
- Joint Base Cape Cod (including Upper Cape Water Reserve).

Opportunities:

- Collaboration between MassDOT and USACE.
- Reduce peak period congestion and crash rates.
- Enhance multimodal accommodation.
- Improve employment opportunities.

## STEP 3: DEVELOP A RANGE OF DESIGN ALTERNATIVES

Based on the review and evaluation of existing and future traffic conditions, a range of design alternatives were developed adhering to MassDOT's standard approach to alternatives development. This approach focuses on:

- Satisfying the study goals and objectives.
- Considering the issues, constraints, and opportunities.
- Minimizing impact to property, community facilities, and environmental resources.

Transportation improvements were developed in accordance with the requirements of MassDOT's Highway Development and Design Guide and reflect a commitment to complete streets and mode shift objectives to the degree appropriate for each individual location, consistent with the principles of MassDOT's Healthy Highway's Transportation Policy Directive. This policy seeks to increase and encourage the use of a greater variety of transportation modes including walking, bicycling, and transit.

Recognizing that Cape Cod is a major summertime tourist destination, trying to design transportation improvements to accommodate the summertime peak period traffic volumes would require the construction of very substantial infrastructure improvements. The study team, in consultation with the study Working Group, concluded that this level of infrastructure would likely be considered an 'over-build' – not in line with the type or scale of development desired on Cape Cod. As a result, the focus of the study was limited to improvements to year-round problem intersections (Exhibit ES-7). The goal of the transportation improvements design was to accommodate traffic volumes related to the future (2040) fall weekday P.M. peak period and include further improvements to accommodate the summer Saturday peak period, as feasible

Year-round problem intersections are forecast to operate as a LOS E or F during at least one summer and non-summer peak travel period in 2040 and include those designated as high-crash locations. Overall, eight locations were advanced to alternatives development. Several of these are a combination of more than one year-round problem intersection, as proximity to one another resulted in them operating as a single traffic point.

### Local Intersection Alternatives

Alternatives for local intersections include Transportation System Management (TSM) improvements. Examples of TSM improvements include traffic signal optimization, including

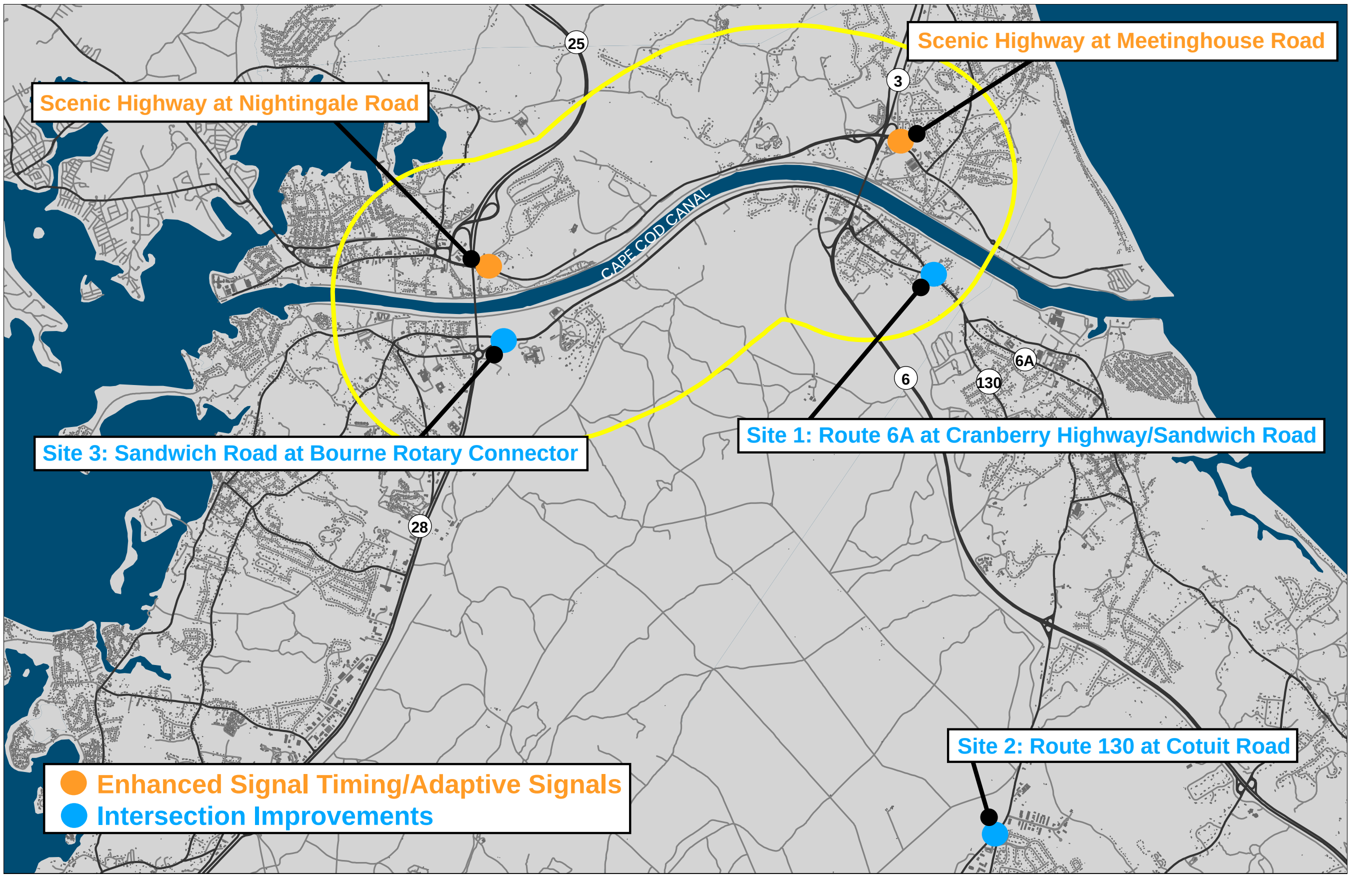
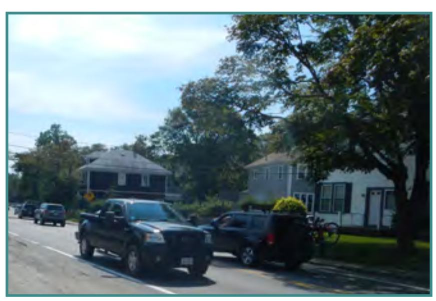
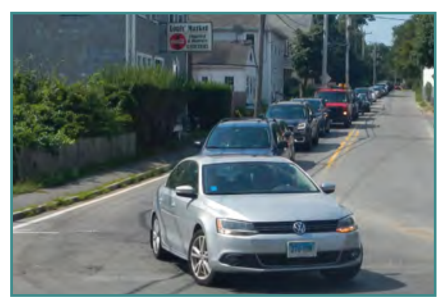



***Exhibit ES-8 Local Intersection Improvement Locations***

*Traffic on local roads. Some local trips must use regional highways (left) and the connecting, local roads are narrow (center). One left turn can create significant traffic on many local roads (right).*





adaptive signal controls, installation of new traffic signals and/or signal control equipment, installation of turning lanes, and improved roadway markings and signage. Improvements at the following locations (Exhibits ES-8 and ES-9) were evaluated:

- Scenic Highway at Meetinghouse Lane (TSM improvements)
- Scenic Highway at Nightingale Road (TSM improvements)
- Sandwich Road at Bourne Rotary Connector
- Route 6A (Sandwich Road) at Cranberry Highway
- Route 130 (Forestdale Road) at Cotuit Road

*Exhibit ES-9 Local Intersection Improvements*

Site 1

Route 6A (Sandwich Road) at Cranberry Highway


Site 2

Route 130 at Cotuit Road


Site 3

Sandwich Road & Bourne Rotary Connector

## Gateway Intersection Alternatives

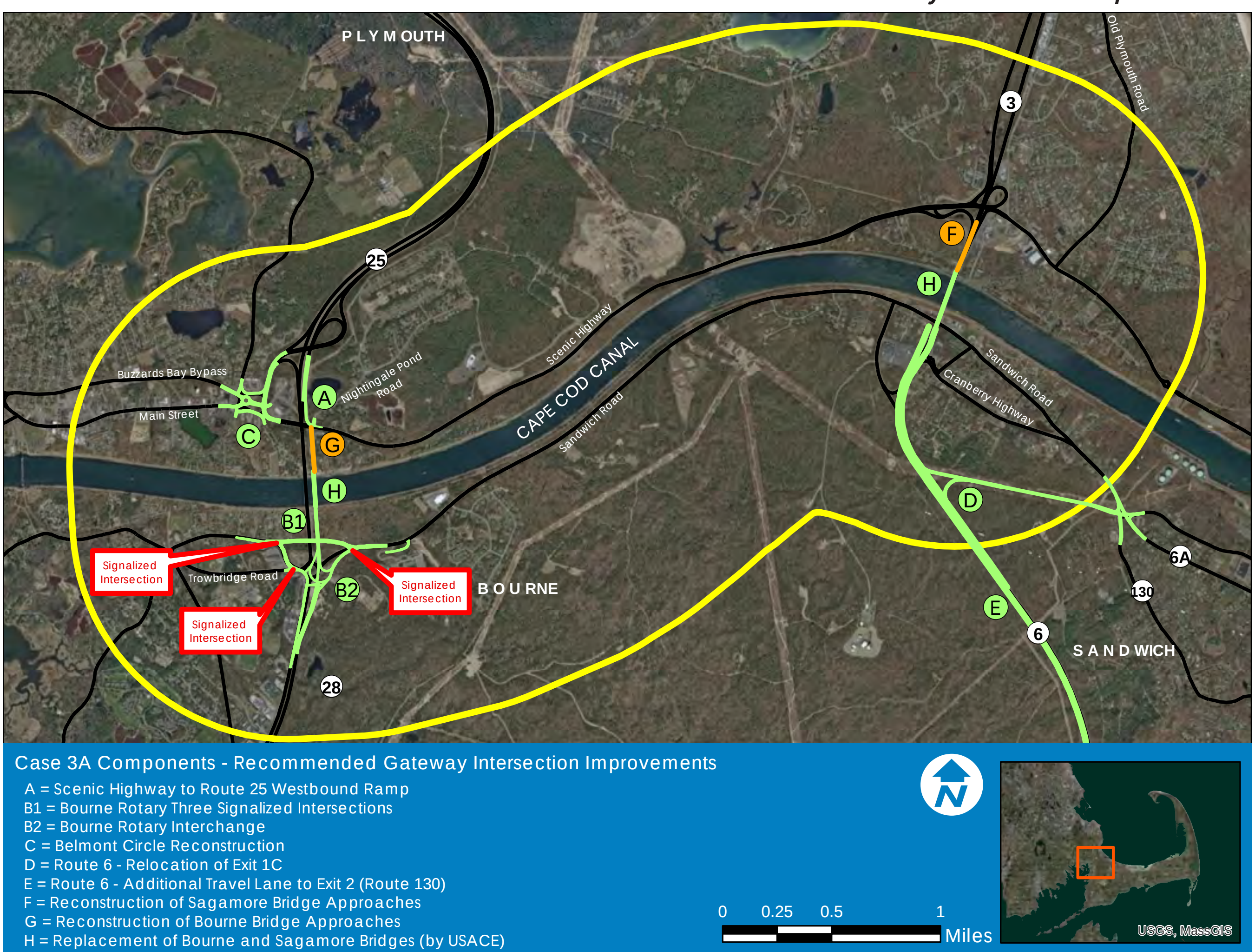
Multiple alternatives were evaluated at the gateway intersections to determine their effectiveness at improving traffic operations and consider their potential impact on environmental resources and property (Exhibit ES-10). The following sections describe the alternatives evaluated at the gateway intersections.

### *Route 6 Westbound at Exit 1C*

Route 6 at Exit 1C (Cranberry Highway) provides an exit and entrance on Route 6 for westbound vehicles only. The geometry of Exit 1C is substandard and not in compliance with current MassDOT highway design standards. The deficiencies of Exit 1C include short acceleration and deceleration lanes and steep grades approaching the Sagamore Bridge.

During summer weekend peak periods, the Route 6 westbound approach to the Sagamore Bridge at the Exit 1C interchange are often characterized by substantial congestion with queues on Route 6 westbound extending 4.4 miles or more, resulting in

***Exhibit ES-10 Potential Gateway Intersection Improvements***




SOURCE: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division. 2013-2014 Orthophotography

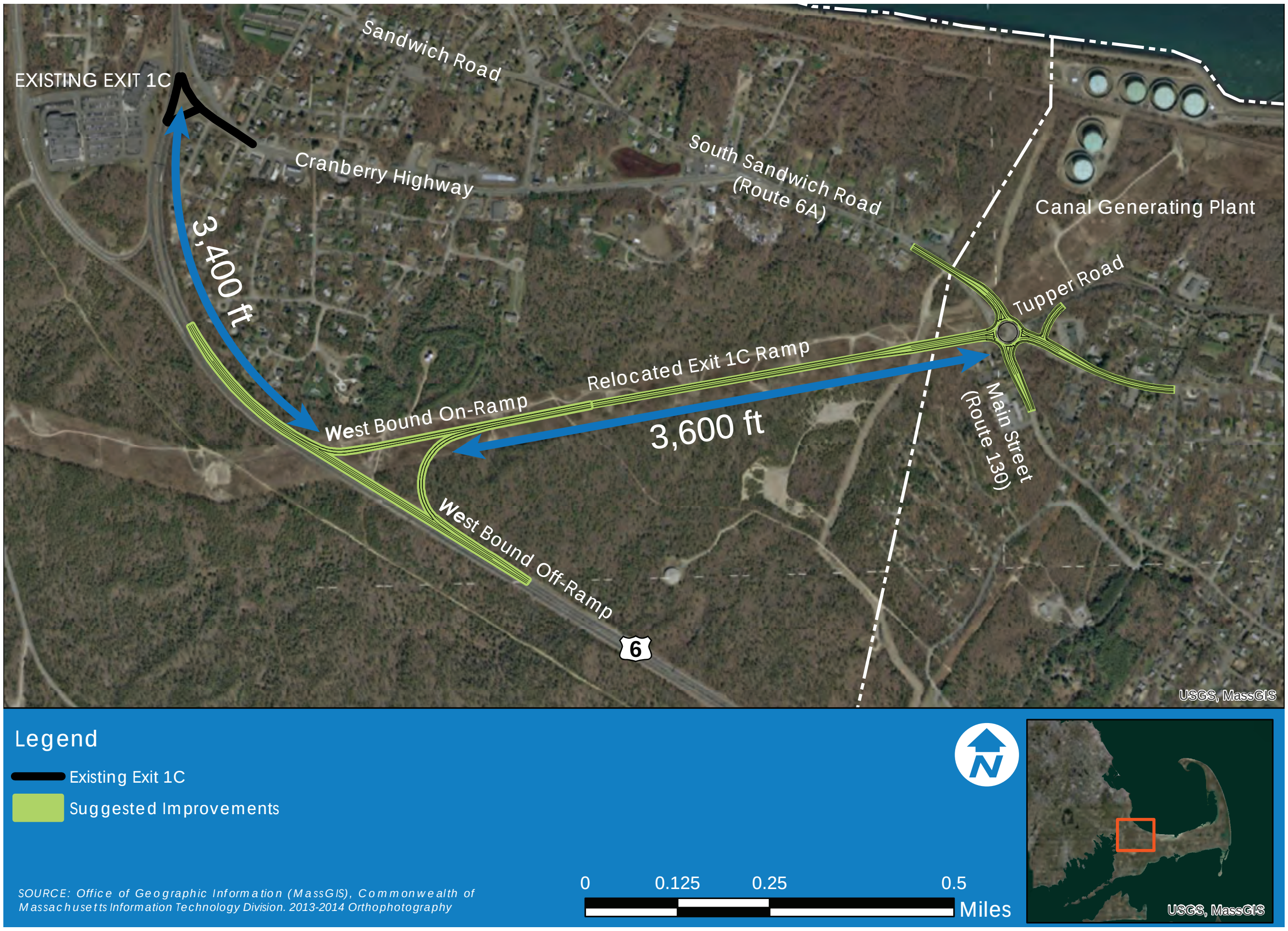



***Exhibit ES-11 Relocation of Route 6 Exit 1C***

LOS F conditions. This congestion results in substantial delays (average delay of 11.4 minutes) for vehicles heading off-Cape. The summer peak period delay on Route 6 westbound is forecast to increase to 13.5 minutes by 2040.

In addition to improving traffic operations on Route 6 westbound, it is anticipated that the future profile of a potential replacement Sagamore Bridge would be less steep than the six-percent grade on the existing bridge. This would result in a longer bridge, which would tie into Route 6 further east, requiring the relocation of the existing Exit 1C.

Therefore, the relocation of Route 6 Exit 1C from its existing location at the base of the south end of the Sagamore Bridge was evaluated. The selection of a new location for the Exit 1C interchange would need to be informed by existing land uses adjacent to Route 6 (residential neighborhoods, state forest, and JBCC) and comply with Federal Highway Administration (FHWA) guidelines.

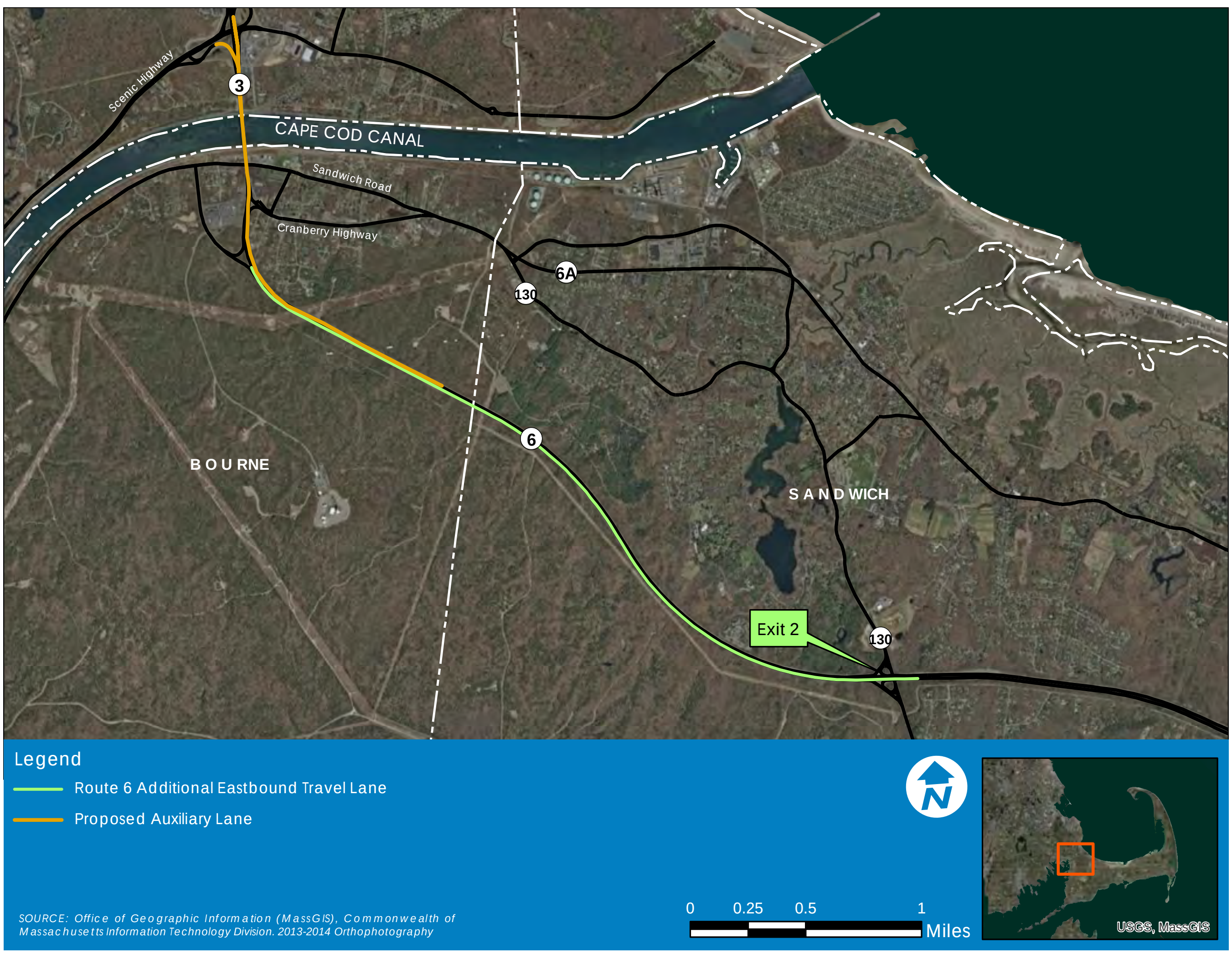
Given these existing constraints, the electrical utility corridor was identified as the most appropriate location for the relocated

interchange. This relocated interchange would provide a roadway connection from Route 6 eastbound to the Route 6A/Route 130 intersection which would be reconstructed as a four-leg roundabout (Exhibit ES-11). This location would have only a minor effect on existing commercial and residential properties and state forest land. No wetland, floodplain, or other regulated water resources would be impacted. These improvements would impact approximately 7.2 acres of land designated as a Priority Habitat for Rare Species.

### *Route 6 Eastbound Travel Lane*

The study team evaluated building an additional travel lane on Route 6 eastbound for approximately 3.4 miles from the Mid-Cape Connector to Exit 2 (Route 130, Exhibit ES-12). It is assumed that this additional travel lane would be constructed concurrent with the construction of a replacement Sagamore Bridge. A replacement Sagamore Bridge in envisioned to include auxiliary lanes extending from the Scenic Highway entrance

**Exhibit ES-12 Route 6 Eastbound Travel Lane**



ramp to Route 3 southbound, over the Sagamore Bridge, to the Mid-Cape Connector entrance ramp to Route 6 eastbound.

An additional eastbound travel lane on Route 6 would act as an extension of this auxiliary lane providing additional capacity and distance for entering vehicles to merge onto the heavily-traveled section of Route 6 eastbound between the Sagamore Bridge and Exit 2 (Route 130). The extension of this additional eastbound travel lane would not be needed beyond Exit 2 because traffic volumes drop substantially after this point. For example, during the future no-build period, traffic volumes west of Exit 2 drop by more than 27%, from 2,765 to 2,000 vehicles, during the non-summer weekday PM peak period.

The construction of an additional eastbound travel lane may impact up to 3.9 acres of rare species habitat. No other regulated environmental resources, such as wetlands or floodplains, would be impacted.

### *Belmont Circle and Bourne Rotary*

Belmont Circle and the Bourne Rotary are located north and south of the Bourne Bridge, respectively. These are two of the most critical intersections in the study area and motorists often must navigate both traffic circles when crossing the Bourne Bridge.

The high traffic volumes and sub-standard design of these unsignalized traffic circles results in severe traffic congestion every day. Each currently operate at LOS F during all peak travel periods during both the summer and non-summer periods resulting in lengthy vehicle queues extending from the approaches to either intersection.

The proximity of these traffic circles means they have a substantial effect on each other. For example, during peak periods, a lengthy queue often forms on the Route 28 southbound approach to the Bourne Bridge, extending several thousand feet north along Route 25. These queues delay other motorists trying to enter Belmont Circle from Route 25 Exit 3 or Scenic Highway. The key to improving traffic operations for both Belmont Circle and Bourne Rotary was recognized as identifying transportation improvements that:

1. **Reduce traffic volumes entering the Belmont Circle and Bourne Rotary.**

2. **Safely accommodate both regional and local traffic.**

3. **Maintain access to local businesses.**

4. **Ensure compatibility with a future replacement Bourne Bridge alignment (likely to the east of the existing bridge).**

*Belmont Circle Reconstruction*

Several alternatives were developed to improve traffic operations at Belmont Circle. To reduce traffic volumes entering Belmont Circle, the construction of a new highway entrance ramp from Scenic Highway westbound to Route 25 westbound is included in each alternative (Exhibit ES-13). All alternatives also include improvements for bicycle and pedestrian accommodations and maintain access to adjacent properties.

A Route 25 westbound entrance ramp from Scenic Highway would result in approximately 0.2 acres of impact to land within an interim wellhead protection area. No wetland, floodplain, or rare species habitat areas would be impacted. This ramp would be partially within an area containing natural gas lines, requiring close coordination with the utility company to determine if relocation of these gas lines would be necessary.

Ultimately, the alternatives evaluated for this study (Exhibit ES-14) included:

- Three-leg roundabout with signalized intersection (Alternative 1)
- Three-leg roundabout with signalized intersection and fly-over ramp (Alternative 1A)
- Four-leg roundabout (Alternative 2)

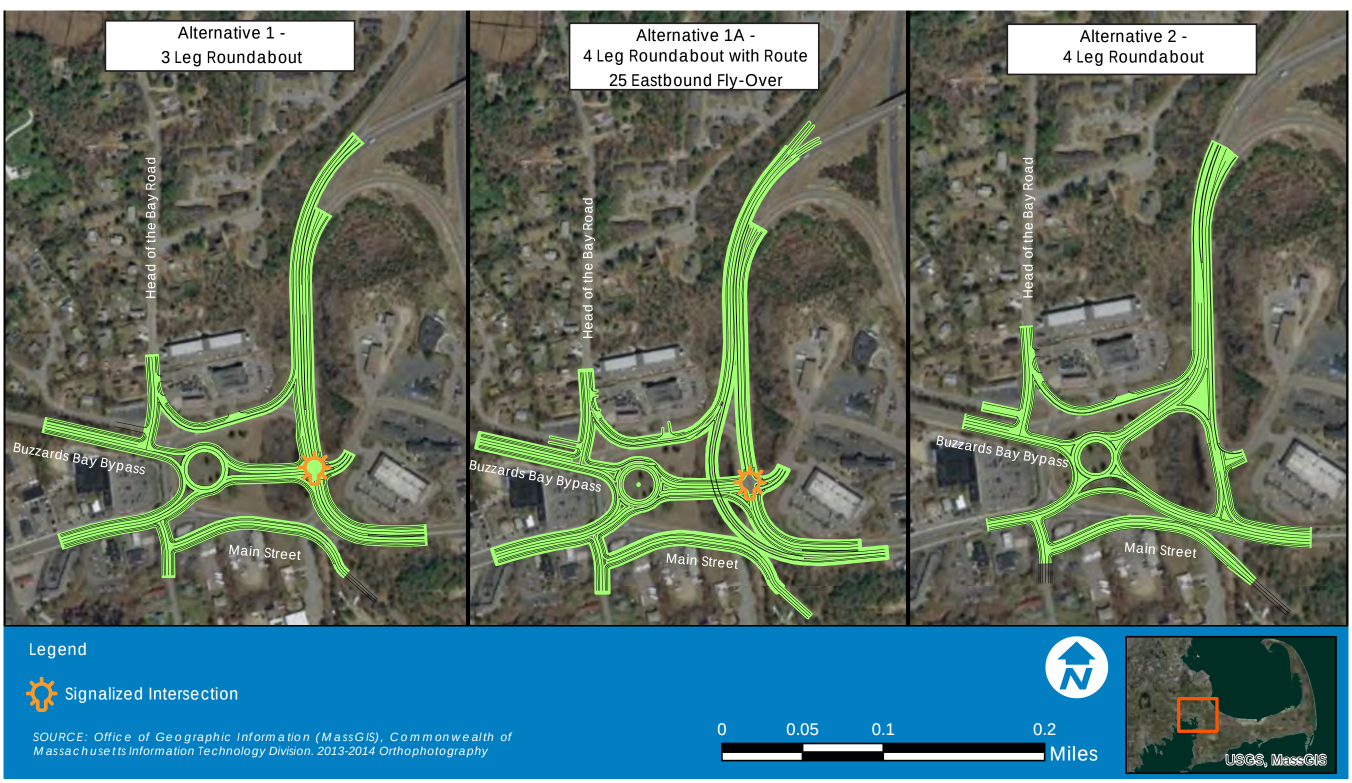
Each of the three alternatives for the reconstruction of Belmont Circle would impact a moderate amount of wetland resources and 100-year floodplain. Open space and residential and commercial property acquisitions may also be required.

Alternative 1 – Three-leg roundabout with signalized intersection – was advanced for further study during the travel model analysis. Under Alternative 1, maximum queue lengths during the non-summer weekday peak period for all approaches except the Buzzards Bay Bypass would be reduced to less than half of the future no-build condition. The reductions in maximum peak period queue length during the summer Saturday peak period is even more favorable with all approaches experiencing substantial reductions.

Overall, this alternative was selected because it would improve traffic operations with a simpler, less costly design (since it does not include the bridge structure that is included in Alternative 1A).


***Exhibit ES-13 Scenic Highway Westbound to Route 25 Westbound Ramp***

***Exhibit ES-14 Alternatives Evaluated – Belmont Circle***



*Bourne Rotary Reconstruction*

Alternatives for the Bourne Rotary were conceived to be compatible with the existing Bourne Bridge and the anticipated vertical and horizontal alignment of a future Bourne Bridge. Each of these alternatives assumes that local intersection improvements for Sandwich Road at the Bourne Rotary Connector (noted above) are completed. A larger-scale alternative to reconstruct Bourne Rotary as a highway interchange was also explored.

As with the Belmont Circle alternatives, all Bourne Rotary alternatives would include improvements to bicycle and pedestrian accommodations and maintain access to adjacent properties. Sidewalks, crosswalks, and bicycle lanes would be constructed on Old Sandwich Road to provide east-west access under the Bourne Bridge. These facilities would enhance access between public facilities such as the Upper Cape Cod Technical High School and the Bourne Middle and High Schools.

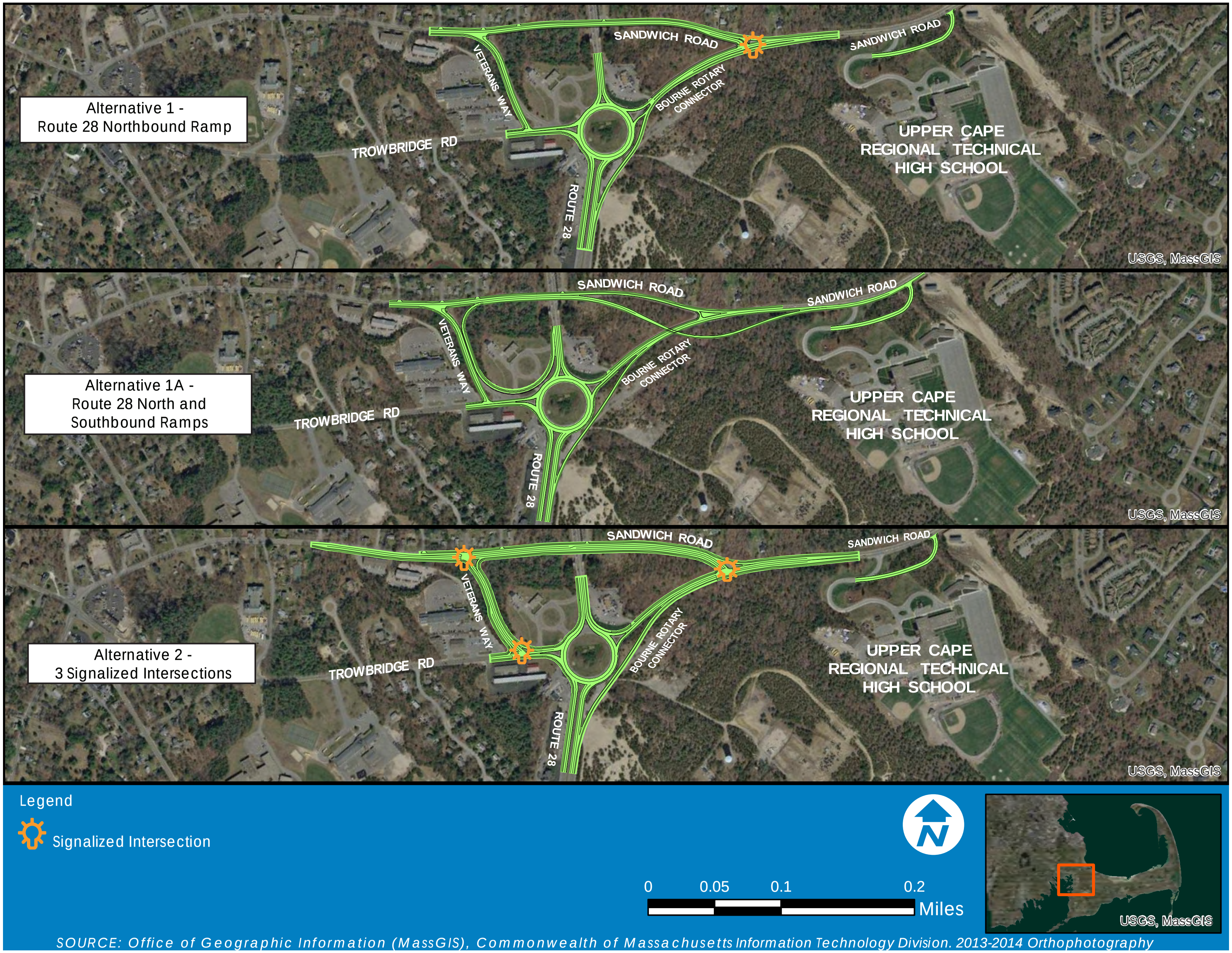
Bourne Rotary alternatives evaluated (Exhibit ES-15) included:

- Route 28 northbound ramp (Alternative 1)
- Route 28 northbound and southbound ramp with Sandwich Road underpass (Alternative 1A)
- Three signalized intersections (Alternative 2)

None of the three alternatives would impact wetland resources, 100-year floodplain, or rare species habitat. All alternatives may require minor property acquisitions from the USACE and adjacent residential and commercial properties.

Alternative 2 – Three Signalized Intersections – was advanced for further study during the travel model analysis. This alternative was selected because it would result in acceptable traffic operations at all three signalized intersections. The Veterans Way at Trowbridge Road intersection would operate at LOS B and C for the non-summer weekday and summer Saturday peak periods, respectively. The Veterans Way at Old Sandwich Road intersection would operate at LOS C and D and the Sandwich Road at Bourne Rotary Connector intersection would operate at LOS C for both time periods. Based on the conceptual design, this alternative could be incorporated into the Bourne Rotary Interchange alternative and, ultimately, a potential replacement Bourne Bridge.

***Exhibit ES-15 Alternatives Evaluated – Bourne Rotary***




SOURCE: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division. 2013-2014 Orthophotography

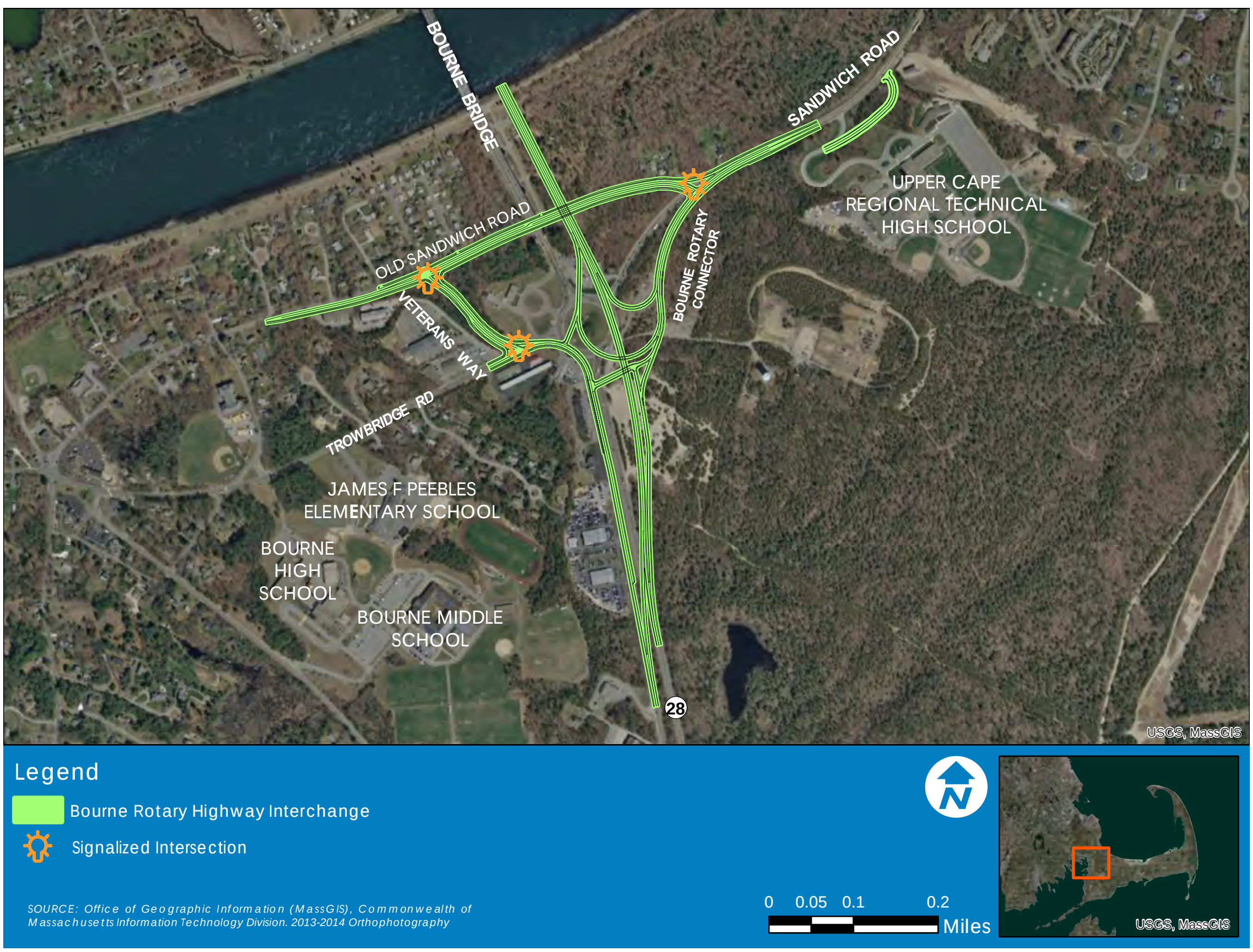
*Bourne Rotary Interchange*

A larger-scale alternative to improve traffic operations at the Bourne Rotary was evaluated. This alternative involves the reconstruction of the Bourne Rotary as a highway interchange and includes construction of Bourne Rotary Alternative 2 – three signalized intersections. This alternative was conceived to be constructed concurrent with an assumed replacement of the Bourne Bridge, with an alignment immediately east of the existing bridge (Exhibit ES-16).

The reconstruction of the Bourne Rotary as a highway interchange involves the removal of the Rotary and the construction of a grade-separated highway ramp system that would allow vehicles to enter Route 28 (northbound or southbound) directly from Sandwich Road (via the Bourne Rotary Connector) or Trowbridge Road. Local traffic would pass directly over Route 28 on an overpass.

The reconstruction of the Bourne Rotary as a highway interchange would substantially reduce peak period queuing on

**Exhibit ES-16 Bourne Rotary Interchange**



the Rotary approach roadways including Route 28 (northbound and southbound), Trowbridge Road, and the Bourne Rotary Connector. Currently, the Bourne Rotary suffers from LOS F conditions during all peak periods. Construction of a highway interchange would improve traffic operations, forecast to range from LOS A to LOS C conditions.

A Bourne Rotary Interchange alternative would not impact wetland resources, 100-year floodplains, or land owned by the Town of Bourne. This alternative may impact a minor amount of rare species habitat (0.2 acres). The interchange alternative would require the acquisition of approximately 0.4 acres of land from the USACE and 0.3 acres of residential property. The interchange may also require approximately 2.2 acres of commercial land east of the Rotary.

### *Bourne and Sagamore Bridges - Potential Replacement Design Features*


*Historic postcard depicting the Bourne Bridge*
*Source: Boston Public Library*

The Sagamore and Bourne Bridges both opened in 1935 and are nearing the end of their usable service lives. For this planning study, it was assumed that the USACE will determine that both Bridges require complete replacement. Identical in design, each highway bridge is approximately 48 feet in width, providing four 10-foot-wide traffic lanes (two lanes in each direction), with no roadway shoulder or median. A single five-foot wide sidewalk and a two-foot safety walk are provided along opposite sides of the Bridges.

Based on the local topography, existing land uses, and environmental resources, it is assumed that these replacement bridges would be constructed immediately adjacent to and inside of the existing Bridges. A replacement Bourne Bridge would be built to the east of the existing bridge and a replacement Sagamore Bridge would be built to the west of the existing bridge.

It is also assumed that replacement Canal Bridges would be multimodal structures designed to current MassDOT highway design standards and policies. Specifically, a bridge with a much wider cross section is envisioned to accommodate all users. This cross section could be up to 138 feet wide, including two 12-foot lanes in each direction and a single 12-foot auxiliary traffic lane in each direction. These lanes would be separated by a 10-foot wide median. Bicyclists and pedestrians could cross the bridge on a 12-foot wide shared-use path on one side of the bridge with a six-foot wide pedestrian sidewalk on the other side of the bridge (Exhibit ES-17).

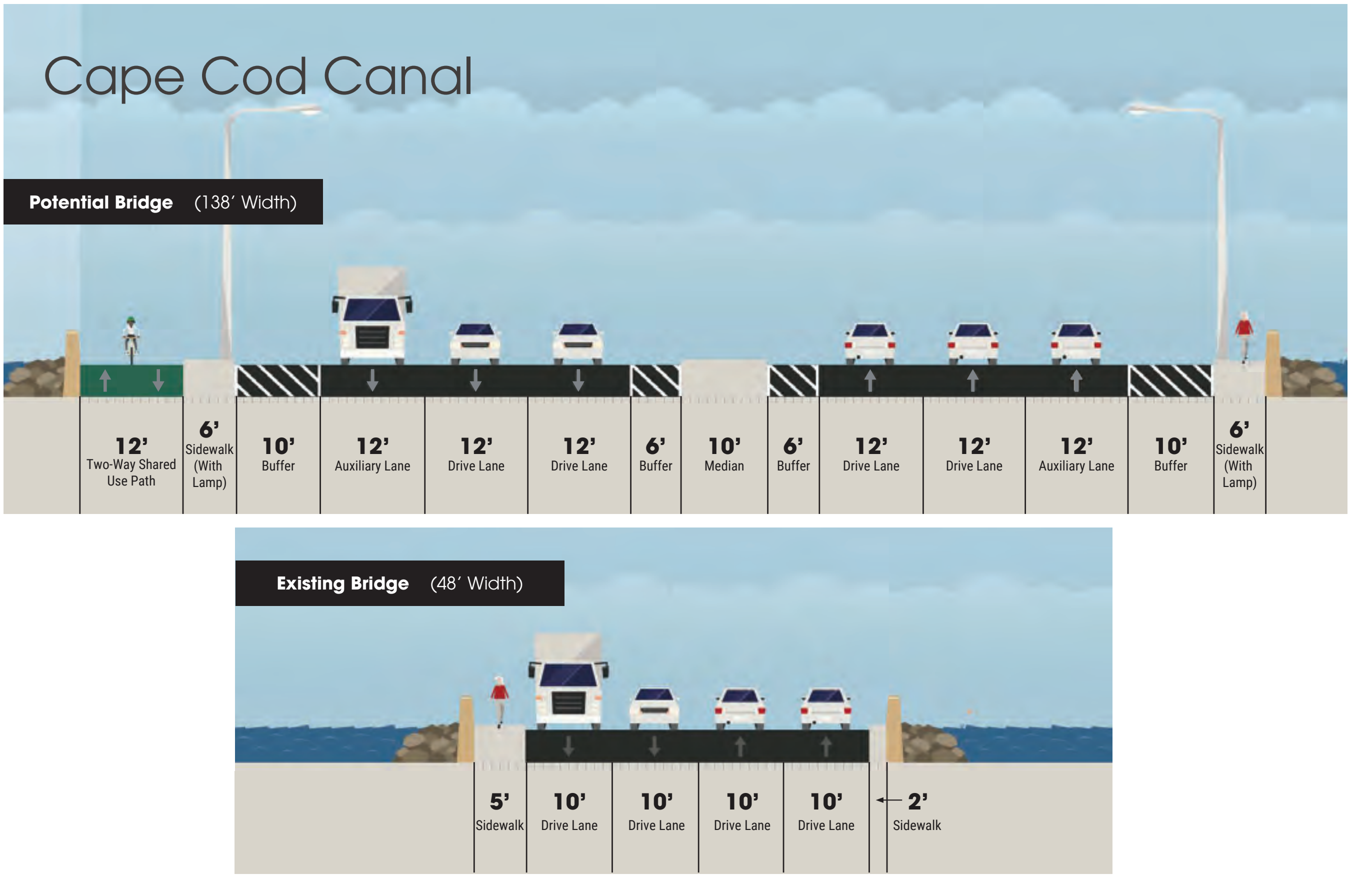



***Exhibit ES-17 Potential Cross Section of Replacement Canal Bridges***

## Multimodal Transportation Alternatives

Improvements to multimodal transportation facilities in the study area were evaluated, including improvements to pedestrian, bicycle, and park-and-ride facilities. This evaluation considered improvements to existing facilities, new connections between existing facilities, and the construction of new facilities.

## Bicycle and Pedestrian Alternatives

The following sections describe potential improvements to the bicycle and pedestrian facilities in the study area.

*Improved Connections to Canal Service Road (Bike Path)*

Access and use of the Canal service road (bike path) by all users could be improved through the construction of new accessible connections to the bike path from the local roadway network. Gaps in the accessible connections to the Canal bike path road were identified both north and south of the Canal. Three potential locations were identified to provide access to the bike path from local roads: including new connections from Pleasant Street and the Bourne Ball Field (south of the Canal in Bourne) and Old Bridge Road on the north side of the Canal in Bourne.

*Bicyclists on the Canal bike path road.*

*Improved Access to/across the Canal*

Several potential locations to improve bicycle/pedestrian travel across the Canal were evaluated. Sidewalks that approach the bridges could be widened and reconstructed to meet ADA-compliance. Additionally, gaps in the sidewalk network could be completed to allow uninterrupted sidewalk access across the Canal to the local roadway network and the Canal bike path.

*Improved Accommodation along Bus Routes*

Multimodal travel in the study area could be enhanced through improvements in bicycle and pedestrian facilities along bus routes. This is an important part of an overall effort to create an integrated multimodal transportation system.

Several key bus routes in the study area, including those along County Road and Route 151 along the Bourne Run bus line and Route 6A, Route 130, Service Road, and Quaker Meeting House Road along the Sandwich Line require pedestrian and bicycle facilities. The roadways along these bus routes lack consistent ADA-compliant sidewalks, roadway shoulders suitable for bicycle travel, bus shelters, and bike racks.

*Multimodal Transportation Center*

Multimodal centers provide commuters and other travelers with free and secure parking when transferring to carpool or transit services. These centers are beneficial for reducing the cost of daily commutes and reducing traffic volumes by limiting single-occupant vehicle travel.

Constructing an additional Park & Ride lot at Exit 2 (Route 130) was determined feasible because MassDOT owns sufficient land at the southwest quadrant of the interchange, there are no wetland resources present, and the Plymouth & Brockton bus line and CCRTA Sandwich line already pass by this location. Furthermore, the western terminus of the upcoming Service Road shared-use path is Route 130 at this location. The hilly topography of this parcel may initially limit the size of the lot to approximately 100 cars, but a larger lot could eventually be constructed with additional site grading.

## STEP 4: ANALYZE DESIGN ALTERNATIVES BASED ON EVALUATION CRITERIA

The following sections describe the analysis conducted using the regional travel demand model to identify the most effective combination of transportation improvements in the study area.

## Regional Travel Analysis Modeling

This study's travel analysis model provides a method for combining groups of potential transportation improvements (known as 'cases') to evaluate their effectiveness. The travel analysis model also reveals potential new travel patterns that may cause unforeseen traffic congestion in other locations. This exercise clarified the level of transportation improvements necessary to provide acceptable traffic operations in the study area for the 2040 non summer weekday PM period without overbuilding in a manner inconsistent with the character of Cape Cod.

Seven cases were selected for analysis to provide logical and comprehensive groups of improvements. These seven cases generally build upon one another with the first cases incorporating smaller intersection improvements and subsequent cases including an increasing number of transportation improvements. The nine different components of the travel analysis model cases are listed on Table ES-4 and shown on Exhibit ES-18.

Cases 1, 1A, 1B, 2, and 2B were analyzed with the existing Canal bridges remaining in place as the improvements proposed under these cases could proceed as stand-alone projects without requiring any future action. However, if the USACE proceeds with the replacement of the Canal bridges, these improvements, with modest modifications, would still be compatible with the assumed location and layout of the replacement bridges. Cases 3 and 3A assume that replacement Canal bridges are in place. Case 3A differs from Case 3 with the construction of a highway interchange replacing the Bourne Rotary

The effectiveness of each case was determined by performance during the non-summer weekday PM (4:00 – 6:00 PM) and summer Saturday (10:00 AM – 12:00 PM) peak periods, when compared to the future no-build conditions at Belmont Circle and Bourne Rotary in terms of vehicle queues, delay, and level of service. Traffic conditions were also evaluated for the Route 3 southbound and Route 6 westbound approaches to the Sagamore Bridge.

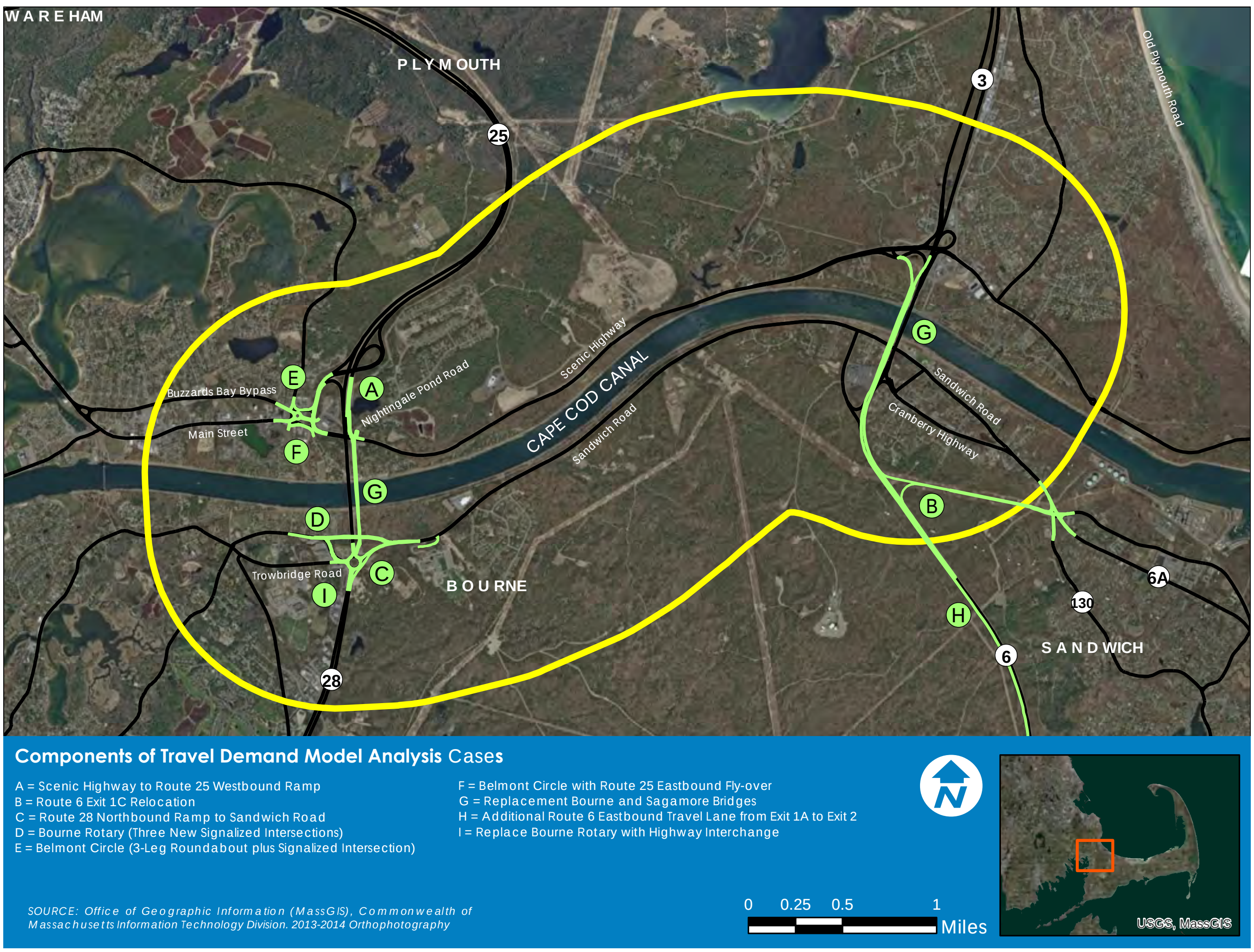
### *Case Analysis Findings*

Because they provide an accurate reflection of traffic conditions throughout the focus area, analysis of the seven-travel demand model cases is predominately based on how these cases would affect traffic operations at Belmont Circle, Bourne Rotary, and the Route 3 and Route 6 approaches to the Sagamore Bridge.

*Table ES-4 Components of Seven Travel Demand Analysis Cases*

| MAP LOCATION (ES-18) | IMPROVEMENTS | CASE 1 | CASE 1A | CASE 1B | CASE 2 | CASE 2B | CASE 3 | CASE 3A |
|---|---|---|---|---|---|---|---|---|
| A | Scenic Highway to Route 25 Westbound On-Ramp | X | X | X | X | X | X | X |
| B | Route 6 Exit 1C Relocation | X | | | X | X | X | X |
| C | Route 28 Northbound Ramp to Sandwich Road | | X | X | X | X | X | |
| D | Bourne Rotary (3 New Signalized Intersections) | | | X | X | X | X | |
| E | Belmont Circle (3-Leg Roundabout plus Signalized Intersection) | | | | X | | X | X |
| F | Belmont Circle with Route 25 Eastbound Fly over | | | | | X | | |
| G | Replacement Bourne and Sagamore Bridges | | | | | | X | X |
| H | Route 6 Eastbound Travel Lane from Exit 1A to Exit 2 | | | | | | X | X |
| I | Bourne Rotary with Highway Interchange | | | | | | | X |

***Exhibit ES-18 Components of Seven Travel Demand Analysis Cases***



In developing the overall findings, the study team remained mindful of the design assumptions that guided the alternatives development process. These design assumptions include a focus on the future year-round problem locations, prioritizing improvements to accommodate the future non-summer weekday peak period and providing further improvements to accommodate the summer Saturday peak period as feasible.

Table ES-5 and Exhibits ES-19 and ES-20 summarize findings for the seven cases analyzed. Table ES-5 provides a summary of the primary measures of effectives for traffic operations at Belmont Circle and Bourne Rotary including average queues, maximum queues, average delays, and LOS.

Exhibit ES-19 and ES-20 provide a comparison of the average delays at Belmont Circle, Bourne Rotary, and the Sagamore Bridge approaches, respectively, during the non-summer period and summer peak periods for the future no-build condition and each of the seven cases analyzed.

The following is a summary of the findings for Case 3A which includes the replacement of both the Sagamore and Bourne Bridges and the other Case 3A transportation improvements listed in Table ES-4.

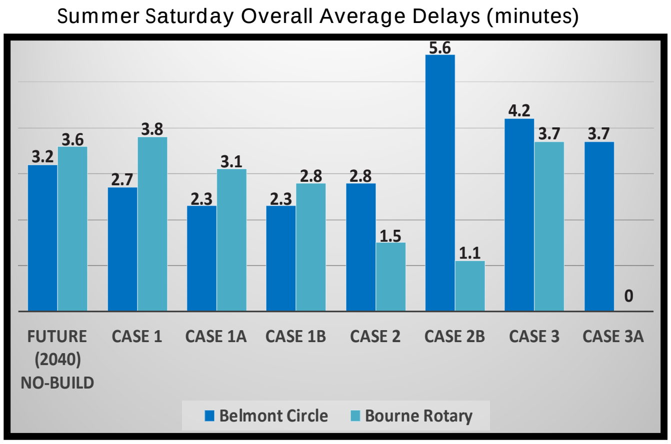
## Economic Analysis

There are several ways in which transportation improvements can affect social and economic conditions within the local area and region in which they occur. From a social and economic standpoint, the most significant effects are changes in accessibility. Accessibility has three components with direct social and economic consequences: travel times, vehicle miles traveled, and mode choices. In this study, travel time differences between the existing and future no-build conditions and the proposed 'cases' represent the primary measurable social and economic effects of alternatives. The following analyses compare the differences in travel times between alternative cases derived in the traffic demand model.

### *Travel Time Savings*

Travel time savings can benefit local and regional economies in several ways:

- It can boost the productivity of labor: travel time savings increase output per hour because workers are less stressed by their commute, more focused and able to spend more time on work tasks.
- Business productivity is boosted by increasing the effective reach of a business to its potential labor force; the same



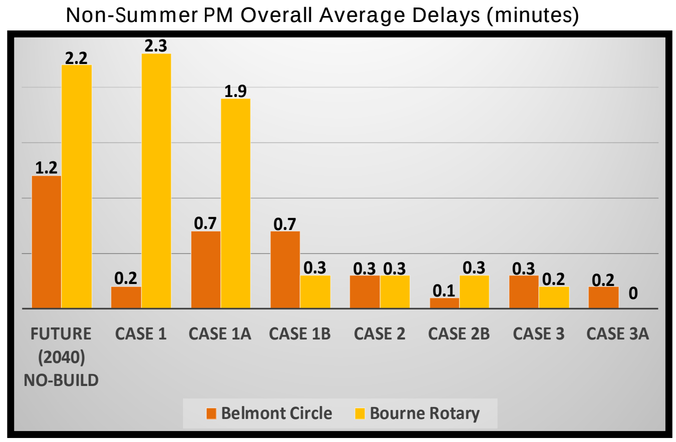
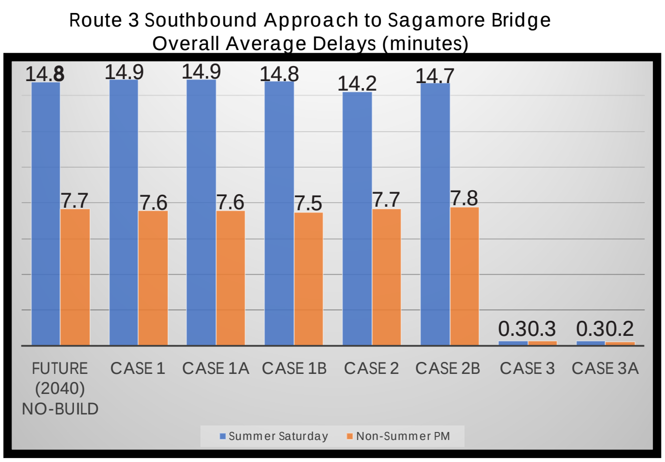
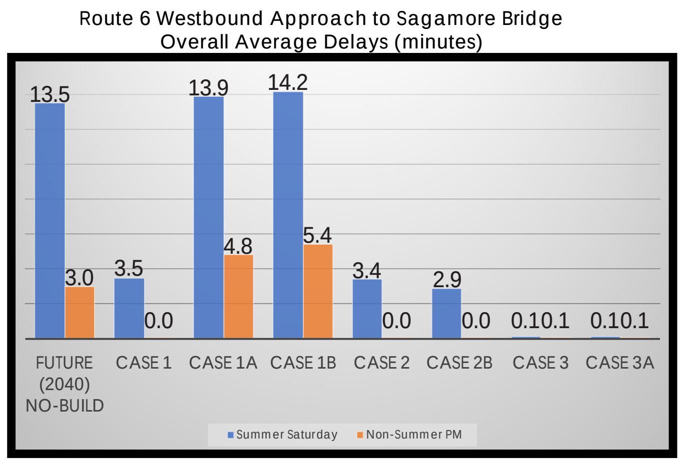




***Exhibit ES-19 Average Non-Summer and Summer Delay - Belmont Circle and Bourne Rotary***

***Exhibit ES-20 Average Non-Summer and Summer Delay – Sagamore Bridge Approaches***




commuting times now apply to a larger geographic area and pool of potential workers.

- Reduction in commuting times benefits workers by increasing the amount of time they can spend in more pleasurable and/or more productive activities than commuting.
- Even very minor travel time savings have direct consequences to the costs of freight and shipping; reduced shipping time means businesses can increase the effective geographic reach of their markets.
- For seasonal visitors – an especially important segment of traveler for the Cape Cod economy – reduced travel time allows more opportunities to spend time on shopping and other recreational activities, thereby enhancing the value of their experience on the Cape and possibly increasing visitor spending within the local economy.
- Reduced travel times for non–work trips enhance the quality of life and personal satisfaction of residents,

*Table ES-5* *Summary of Case Analysis for Queues, Delay, and LOS at Belmont Circle and Bourne Rotary*

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1 | | | FUTURE (2040) BUILD CASE 1A | | | FUTURE (2040) BUILD CASE 1B | | | FUTURE (2040) BUILD CASE 2 | | | FUTURE (2040) BUILD CASE 2B | | | FUTURE (2040) BUILD CASE 3 | | | FUTURE (2040) BUILD CASE 3A | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* |
| **BELMONT CIRCLE** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 65 | 1 | A | 80 | 1 | A | 70 | 29 | D | 470 | 9 | A | 155 | 34 | D | 605 | 33 | D | 575 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | F | 1,780 | 35 | D | 520 | 30 | D | 550 | 142 (2.37) | F | 1,055 | 7 | A | 350 | 8 | A | 330 | 7 | A | 325 | 6 | A | 280 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 85 | 3 | A | 95 | 3 | A | 125 | 5 | A | 170 | 3 | A | 205 | 3 | A | 180 | 3 | A | 215 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 27 | D | 1,085 | 24 | C | 1,115 | 61 (1.02) | F | 1,745 | 14 | B | 560 | 4 | A | 85 | 7 | A | 175 | 5 | A | 100 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 1 | A | 60 | 1 | A | 75 | 7 | A | 210 | 36 | E | 475 | 16 | C | 325 | 29 | D | 400 | 22 | C | 315 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **13.4** | **B** | | **11.8** | **B** | | **42.8** | **E** | | **18.2** | **C** | | **8** | **A** | | **16** | **C** | | **13.8** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1025 | 2 | A | 280 | 2 | A | 435 | 2 | A | 250 | 43 | E | 815 | 18 | C | 485 | 33 | D | 540 | 32 | D | 550 |
| Head of Bay Rd SB | 83 (1.38) | F | 570 | 656 (10.93) | F | 2,700 (0.51) | 451 (7.52) | F | 2,100 | 337 (5.62) | F | 1,640 | 622 (10.37) | F | 2,810 (0.53) | 5 | A | 320 | 940 (15.67) | F | 8,190 (1.55) | 643 (10.7) | F | 8,630 (3.4) | 552 (9.2) | F | 9,570 (3.8) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 12 | B | 305 | 14 | B | 370 | 9 | A | 285 | 9 | A | 290 | 446 (7.43) | F | 2,665 (0.50) | 183 (3.1) | F | 1505 | 133 (2.2) | F | 1,200 |
| Main Street EB | 82 (1.36) | F | 5,755 (1.09) | 126 (2.1) | F | 6,140 (1.16) | 185 (3.08) | F | 6,140 (1.16) | 172 (2.87) | F | 6,140 (1.16) | 17 | C | 1,135 | 243 (4.05) | F | 6,020 (1.14) | 45 | E | 4,995 (0.94) | 80 (1.3) | F | 12,810 (5.1) | 87 (1.5) | F | 12,900 (5.2) |
| Scenic Highway WB | 125 (2.08) | F | 10,605 (2.01) | 161 (2.68) | F | 11,610 (2.20) | 154 (2.57) | F | 10,630 (2.01) | 154 (2.57) | F | 10,525 (1.99) | 3 | A | 235 | 553 (9.22) | F | 11,800 (2.23) | 147 (2.45) | F | 2,950 (0.56) | 315 (5.3) | F | 11,605 (4.6) | 308 (5.1) | F | 11,050 (4.4) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **160.8 (2.68)** | **F** | | **135.8 (2.26)** | **F** | | **130.6 (2.18)** | **F** | | **170.6 (2.84)** | **F** | | **319.2 (5.32)** | **F** | | **250.8 (4.2)** | **F** | | **222.4 (3.7)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 17 | C | 65 | 30 | D | 1,065 | 2 | A | 0 | 2 | A | 0 | 2 | A | 0 | 2 | A | 35 | | | |
| Trowbridge Rd EB | 75 (1.25) | F | 840 | 394 (6.57) | F | 3,465 (0.66) | 456 (7.6) | F | 520 | 378 (6.3) | F | 3,420 (0.65) | 33 | D | 125 | 20 | C | 160 | 17 | C | 140 | 19 | C | 150 | | | |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | F | 1,275 | 67 (1.12) | F | 85 | 17 | C | 325 | 13 | B | 265 | 11 | B | 300 | 7 | A | 185 | 11 | B | 240 | | | |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 18 | C | 1,085 | 29 | D | 1,265 | 32 | D | 435 | 40 | E | 640 | 49 | E | 975 | 20 | C | 0 | | | |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **139.5 (2.33)** | **F** | | **113.5 (1.89)** | **F** | | **20** | **C** | | **18.25** | **B** | | **18.75** | **C** | | **13** | **B** | | | | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Route 25 SB | 280 (4.67) | F | 8,885 (1.68) | 329 (5.48) | F | 9,935 (1.88) | 333 (5.55) | F | 10,000 (1.89) | 337 (5.62) | F | 10,170 (1.93) | 3 | A | 0 | 3 | A | 25 | 3 | A | 0 | 3 | A | 125 | | | |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | F | 2,225 | 152 (2.53) | F | 1525 | 213 (3.55) | F | 1,645 | 249 (4.15) | F | 4,705 (0.89) | 62 (1.03) | F | 915 | 136 (2.27) | F | 1,370 | 378 (6.3) | F | 3,200 (1.3) | | | |
| Route 28 NB | 301 (5.02) | F | 4,135 (0.78) | 189 (3.15) | F | 3,605 (0.68) | 280 (4.67) | F | 5,375 (1.02) | 13 | B | 445 | 409 (6.82) | F | 8,050 (1.52) | 268 (4.47) | F | 5,820 (1.10) | 344 (5.73) | F | 6,930 (1.31) | 486 (8.1) | F | 9,095 (3.6) | | | |
| Sandwich Rd WB | 27 | D | 1475 | 135 (2.25) | F | 6,430 (1.22) | 139 (2.32) | F | 6,095 (1.15) | 198 (3.3) | F | 9,700 (1.84) | 24 | C | 150 | 25 | D | 240 | 24 | C | 200 | 21 | C | 0 | | | |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **226 (3.77)** | **F** | | **190.25 (3.17)** | **F** | | **171.25 (2.85)** | **F** | | **89.5 (1.49)** | **F** | | **126.75 (2.11)** | **F** | | **222 (3.7)** | **F** | | | | |

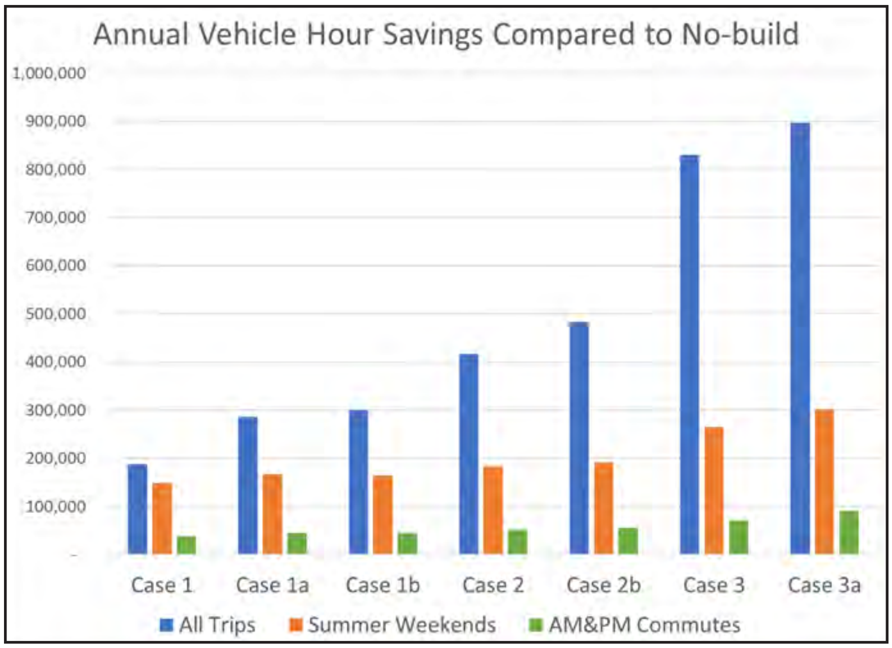
*Notes:*
*LOS E and LOS F movements for the existing and future no-build problem locations are* **bold**
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Data not available for Case 3A at Bourne Rotary. As a highway interchange, analysis at this location was completed with Synchro software, not VISSIM™ software as was used for other locations.*
*Results for Case 3A for the intersections adjacent to the Bourne Rotary Interchange are shown in Chapter 4 on Table 4-29.*

making Cape Cod a more desirable place to live and work, with consequent effects on property values and business location decisions.

Exhibit ES-21 presents annual vehicle hour savings compared to no-build for all trips, including the non-summer weekday PM and summer Saturday peak hours, plus non-peak trips. While the average delay at Belmont Circle for Case 3A is greater than the Future No-Build condition (Exhibit ES-19). , Exhibit ES-21 demonstrates that overall annual vehicle savings for all trips is greatest for Case 3A.

The greater level of transportation investment in Cases 2B, 3, and 3A compared to the other alternatives leads to a greater reduction in travel times when all peak and non-peak trips are considered. As noted, these reductions in travel times can improve not only

***Exhibit ES-21 Annual Vehicle Hours Savings compared to No-Build***




*Note: The hours saved for the combination of the 'summer Saturday' and 'AM and PM commute' do not equal 'all trips' in Exhibit ES-21 because there are time periods included for 'all trips' calculation that are not included in either the non-summer weekday PM or summer Saturday peak periods.*

commuter satisfaction but also business productivity, including accessibility to a larger labor force, making the Cape more attractive for new businesses and investment to expand existing businesses.

## Cost Estimates

Conceptual cost estimates were prepared for each of the potential transportation improvements and the combination of these improvements used for the travel model case analysis (Tables

Table ES-6 Summary of Conceptual Cost Estimate by Location ($ million)

| MAP LOCATION (ES-18) | IMPROVEMENTS | 2017 | 2030 | 2040 |
|---|---|---|---|---|
| A | Scenic Highway to Route 25 Westbound Ramp | $7 | $11 | $16 |
| B | Route 6 Exit 1C Relocation | $30 | $51 | $75 |
| C | Route 28 Northbound Ramp to Sandwich Road and Intersection Signalization | $6 | $11 | $16 |
| D | Bourne Rotary Reconstruction (3 Signalized Intersections) | $11 | $18 | $26 |
| E | Belmont Circle Reconstruction | $14 | $23 | $33 |
| H | Route 6 Eastbound Travel Lane | $29 | $48 | $71 |
| I | Bourne Rotary Interchange[1] | $52 | $87 | $127 |
| | Bourne Bridge Approaches[2] | $51 | $84 | $125 |
| | Sagamore Bridge Approaches[2] | $39 | $64 | $95 |

*[1]Includes cost of Bourne Rotary Reconstruction (3 Signalized Intersections).*
*[2]Not a component of the travel case analysis so not included on Exhibit ES-17.*

Table ES-7 Summary of Conceptual Cost Estimate by Travel Model Case ($ million)

| CASE | 2017 | 2030 | 2040 |
|---|---|---|---|
| Case 1 | $37 | $62 | $91 |
| Case 1A | $13 | $22 | $32 |
| Case 1B | $18 | $29 | $42 |
| Case 2 | $62 | $103 | $150 |
| Case 2B | $72 | $121 | $177 |
| Case 3[1] | $181 | $299 | $441 |
| Case 3A[1] | $222 | $368 | $542 |

*[1]Includes highway approaches to Bourne and Sagamore Bridges. Does not include cost of replacement Bourne and Sagamore Bridges.*

ES-6 and ES-7). The cost estimates were based on MassDOT 2017-unit costs per linear foot of new roadway and bridge sections. The cost estimates were escalated by 4.0% per year to develop estimated cost for 2017, 2030, and 2040. This provides an understanding of the increasing cost of these projects at different time periods.

To develop the conceptual estimate, the MassDOT 2017-unit costs were escalated by 4.0% per year to account for inflation. In addition, a 25% to 75% contingency was added to these conceptual costs to account for unknown (but not unexpected) costs related to environmental mitigation, utility relocation, traffic management (police details), and additional structural elements. A lower contingency was used for less complex design alternatives (e.g. local intersection improvements) while a 40% contingency was used for larger, more complex improvement

alternatives (e.g. adding a travel lane to Route 6). A 75% contingency was used for larger projects involving substantial utility conflicts/potential relations (e.g. Route 6 Exit 1C relocation and Scenic Highway to Route 25 ramp).

### *Potential Environmental, Community, and Property Impacts*

A summary of potential impacts upon environmental and community resources, and public and private property by location are provided in Tables ES-8 and ES-9. The boundaries of these resources are based on information from the MassGIS database or generated using other publicly-available information. Potential impacts to these resources are based on conceptual designs for transportation improvements and serve to provide an order-of-magnitude understanding of the potential impact and provide a means to compare alternatives to one another.

*Table ES-8 Potential Environmental Impact by Location*

| MAP LOCATION (ES-18) | IMPROVEMENTS | ENVIRONMENTAL (ACRES) | | | |
|---|---|---|---|---|---|
| | | WETLAND | 100-YEAR FLOODPLAIN[1] | RARE SPECIES | WATER SUPPLY (ZONE I/II IWPA[2]) |
| A | Scenic Highway to Route 25 Ramp | 0 | 0 | 0 | 0.2 |
| B | Route 6 Exit 1C Relocation | 0 | 0 | 7.2 | 5.7 |
| D | Bourne Rotary (3 Signalized Intersections) | 0 | 0 | 0 | 0 |
| E | Belmont Circle (Route 25 Eastbound Flyover) | 0.5 | 5.4 | 0 | 0.5 |
| H | Route 6 Eastbound - Additional Travel Lane | 0 | 0 | 3.9 | 0 |
| I | Bourne Rotary Interchange | 0 | 0 | 0.2 | 0 |

*[1]Conceputal impact to 100-year floodplain calculated in acres*
*[2]IWPA - Interim Well Protection Area*

*Table ES-9 Potential Community and Property Impact by Location*

| MAP LOCATION (ES-18) | IMPROVEMENTS | COMMUNITY (ACRES) | | PROPERTY (ACRES) | | |
|---|---|---|---|---|---|---|
| | | OPEN SPACE | HISTORIC RESOURCES | RESIDENTIAL/ PUBLIC | COMMERCIAL | UTILITY |
| A | Scenic Highway to Route 25 Ramp | 0 | 0 | 0 | 0 | 0.9 |
| B | Route 6 Exit 1C Relocation | 0.6 | 0.2 | 0.2 | 0.9 | 3.8 |
| D | Bourne Rotary (3 Signalized Intersections) | 0.4 | 0 | 0.4 | 0 | 0 |
| E | Belmont Circle (Route 25 Eastbound Flyover) | 0.1 | 0 | < 0.1 | < 0.1 | 0 |
| H | Route 6 Eastbound - Additional Travel Lane | 0 | 0 | 0 | 0 | 0 |
| I | Bourne Rotary Interchange | 0.4 | 0 | 0.3 | 2.2 | 0 |

### *Evaluation Matrix*

Alternatives were compared to the future no-build transportation conditions on their ability to meet the evaluation criteria

established with input from the Working Group at the onset of the study. These evaluation criteria consist of various measures of an alternative's impact on transportation, safety, environmental and community resources, and economic development.

An evaluation matrix compares each of the travel analysis model cases against the future no-build condition. This evaluation matrix characterizes the transportation performance or potential environmental or property impact category based on either quantifiable data (using existing data or data produced for this study) or subjective qualitative measures. Review of an alternative's performance against all the evaluation criteria provides an opportunity to gain a complete understanding of an alternative's potential benefits and impacts prior to making study recommendations.

The matrix uses different symbols to indicate minor, moderate, or substantial benefits or impact. If no impact or benefit is anticipated (or an environmental resource is not present) a neutral symbol is used. The specific definitions used to differentiate minor, moderate, or substantial impact to environmental resources are provided in Exhibit ES-22.

***Exhibit ES-22 Evaluation Matrix - Definition of Benefit and Impact Ratings***

| Alternatives Evaluation Matrix Legend | | | | |
|---|---|---|---|---|
| **Category** | **Benefit Levels** | | | |
| | ◇ | ○ | ◓ | ● |
| **Safety (Emergency Vehicle Response Time)** | **Neutral** | **Minor or No Impact** | **Modest Benefit** | **Substantial Benefit** |
| **Bicycle/Pedestrian (facilities or access)** | | | | |
| | **Impact Levels** | | | |
| | ◇ | ○ | ◓ | ● |
| | **Neutral (No impact or resource not present)** | **Minor or No Impact** | **Modest Impact** | **Substantial Impact** |
| **Wetlands** | | | 5,000 SF - 1 acre of wetlands | > 1 acre of wetlands |
| **Rare Species** | | | > 1 acre of work in rare species habitat | Requires a Conservation Management Permit |
| **Area of Critical Environmental Concern (ACEC)** | | | Impacts land within ACEC | Impacts wetlands within ACEC |
| **100-Year Floodplain** | | | Moderate fill within 100-year floodplain | Substantial fill within 100-year floodplain |
| **Water Supply Protection Areas** | | | Impact to land in DEP IWPA or Zone II | Impact to land in DEP Zone I or ORW |
| **Air Quality/Public Health** | | | Modest reductions in idle time/queueing | Substantial reductions in idle time/queueing |
| **Open Space** | | | Acquisition of open space land | Acquisition of open space affecting or active recreational facilities |
| **Historic Resources** | | | Impacts historic parcel or historic district | Adverse Effect on historic property |
| **Land Use/Economic Development** | | | Modest impact to residential, commercial, or utility-owned property | Substantial impact to residential, commercial, or utility-owned property |

## Exhibit ES-23 Evaluation Matrix - Comparison of Travel Analysis Model Cases

| Alternatives Evaluation Matrix | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | | | 2040 Future No-Build | | Case 1 | | Case 1A | | Case 1B | | Case 2 | | Case 2B | | Case 3 | | Case 3A | |
| | | | Rating | Data | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) |
| Traffic | Vehicle Hours Traveled | Annual | ◇ | 16.3 mil | ○ | 530 | ○ | 659 | ◒ | 860 | ◒ | 1,070 | ◒ | 1,290 | ● | 1,306 | ● | 1,390 |
| | Average Delay at BC & BR (mins) | Summer Sat | ◇ | 6.8 | ○ | 6.5 | ◒ | 5.4 | ◒ | 5.1 | ◒ | 4.3 | ○ | 6.7 | ◒ | 7.9 | ● | 3.7 |
| | | Fall PM | ◇ | 3.4 | ◒ | 2.5 | ◒ | 2.6 | ● | 1.0 | ● | 0.6 | ● | 0.4 | ● | 0.5 | ● | 0.2 |
| Category | | | | | | | | | | | | | | | | | | |
| Safety / Emergency Response Time | | | | | ○ | | ○ | | ◒ | | ◒ | | ◒ | | ◒ | | ● | |
| Bike / Ped (Safety and New Facilities) | | | | | ◇ | | ○ | | ◒ | | ◒ | | ◒ | | ● | | ● | |
| Environmental | Wetlands (acres) | | | | ○ | 0.0 | ○ | 0.0 | ○ | 0.0 | ◒ | 0.3 | ◒ | 0.5 | ◒ | 0.3 | ◒ | 0.3 |
| | Rare Species (acres) | | | | ● | 7.2 | ◇ | 0.0 | ◇ | 0.0 | ● | 7.2 | ● | 7.2 | ● | 11.1 | ● | 11.3 |
| | 100-yr Floodplain (acres) | | | | ◇ | 0.0 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 4.7 | ◒ | 5.4 | ◒ | 4.7 | ◒ | 4.7 |
| | Water Supply (Zone I/II,IWPA) (acres) | | | | ◒ | 5.9 | ○ | 0.2 | ◇ | 0.0 | ◒ | 6.4 | ◒ | 6.4 | ◒ | 6.4 | ◒ | 6.4 |
| Community | Open Space (acres) | | | | ◒ | 0.6 | ○ | 0.2 | ○ | 0.2 | ◒ | 1.1 | ◒ | 1.1 | ◒ | 1.1 | ◒ | 1.1 |
| | Historic Resources (acres) | | | | ◒ | 0.2 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 0.2 | ◒ | 0.2 | ◒ | 0.2 | ◒ | 0.2 |
| Property Impacts | Residential (acres) | | | | ○ | 0.2 | ◇ | 0.0 | ◇ | 0.0 | ○ | 0.5 | ○ | 0.6 | ○ | 0.6 | ○ | 0.5 |
| | Commercial (acres) | | | | ◒ | 0.9 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 0.9 | ◇ | 0.0 | ◒ | 0.9 | ◒ | 0.9 |
| | Utility (acres) | | | | ● | 4.7 | ◒ | 0.9 | ◒ | 0.9 | ● | 4.7 | ● | 4.7 | ● | 4.7 | ● | 4.7 |
| Economic Impact | | | | | ◒ | | ◒ | | ◒ | | ● | | ◒ | | ● | | ● | |
| **2030 Cost ($ millions)** | | | | | | **60** | | **20** | | **30** | | **100** | | **120** | | **300** | | **370** |

The complete Evaluation Matrix is provided in Exhibit ES-23. Ultimately, review of the completed evaluation matrix and consultation with the Working Group and the public aided MassDOT's decision-making process to identify which case to recommend for advancement into MassDOT's project development process.

## STEP 5: PROVIDE RECOMMENDATIONS TO MEET STUDY GOALS AND OBJECTIVES

### Gateway Intersection Improvements

For each of the cases, the results of the traffic analysis were evaluated and the potential benefit and impact on the various evaluation criteria categories were determined, as shown on the evaluation matrix.

**The components of Case 3A (Table ES-10 and Exhibit ES-24) were identified as the recommended gateway intersection improvements because they most effectively satisfy the study goals and objectives.**

Case 3A would:

- Provide the greatest long-term improvement in accessibility and mobility for Cape Cod residents, employers, and visitors;
- Provide a reliable multimodal transportation system to assure public safety in the event of an emergency evacuation of Cape Cod; and
- Accommodate the rehabilitation or replacement of the Canal bridges, envisioned as having two travel lanes and one auxiliary lane in each direction.

*Table ES-10 Components of Case 3A - Recommended Gateway Intersection Improvements*

| MAP LOCATION (ES-18) | RECOMMENDED GATEWAY INTERSECTION IMPROVEMENT |
|---|---|
| A | Scenic Highway to Route 25 Westbound Ramp |
| B | Bourne Rotary Interchange |
| C | Belmont Circle Reconstruction |
| D | Route 6 – Relocation of Exit 1C |
| E | Route 6 – Additional Travel Lane to Exit 2 (Route 130) |
| F | Reconstruction of Sagamore Bridge Approaches |
| G | Reconstruction of Bourne Bridge Approaches |
| H | Replacement of Bourne and Sagamore Bridges (By USACE) |

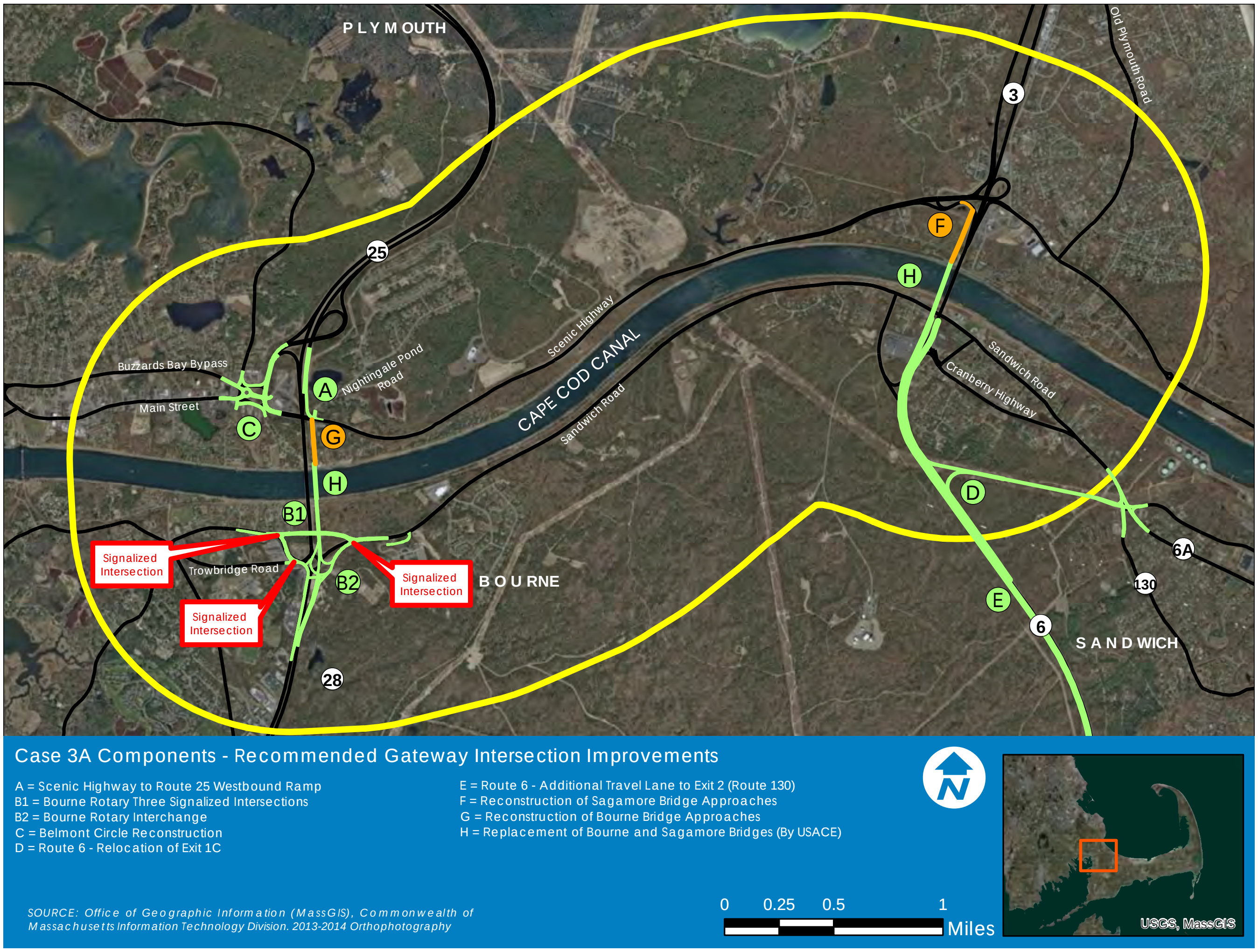



***Exhibit ES-24 Recommended Gateway Intersection Improvements – Case 3A***

## Multimodal Transportation Improvements

This study identifies a series of multimodal transportation improvements that satisfy study goals and objectives and reflect the study findings and public feedback gathered as part of the study. The location and conceptual cost of this study's recommended transportation improvements are provided in Table ES-11.

## Roadway Improvements

Recommendations for improvements to the study area roadway system were developed based on the travel model analysis and potential impact to environmental and community resources and public and private property. The roadway recommendations are presented in two groups: local intersection improvements and larger improvements to gateway intersections.

*Table ES-11 Recommended Multimodal Transportation Improvements*

| TRANSPORTATION MODE | RECOMMENDED IMPROVEMENT | LOCATION | MAJOR STAKEHOLDERS | COST ($ MILLION) |
|---|---|---|---|---|
| **MULTIMODAL** | | | | **2017 COST** |
| New bicycle/pedestrian connections to Canal bike trail | | Various locations in Bourne | Town of Bourne / MassDOT / USACE | $25K - $50K per location |
| Bicycle/Pedestrian Facility Improvements | | Sagamore Bridge Approaches / Adams Street | MassDOT / USACE | 3.9 |
| Bicycle/Pedestrian Facility Improvements | | Bourne Bridge Approach (north) | MassDOT / USACE | 0.8 |
| Bicycle/Pedestrian accommodation along bus routes: add sidewalks /crosswalks / roadway shoulder /bike racks / bus shelters | | Various locations along bus routes in Bourne & Sandwich | Towns of Bourne and Sandwich / MassDOT | Varies by location |
| Park and Ride Lot | | Route 6 Exit 2 (Route 130) | MassDOT | 2.8 |
| **LOCAL INTERSECTION ROADWAY IMPROVEMENTS** | | | | **2017 COST** |
| Route 6 at Cranberry Highway | | Bourne | Town of Bourne / MassDOT | 0.6 |
| Route 130 at Cotuit Road | | Sandwich | Town of Sandwich / MassDOT | 1.0 |
| Sandwich Road at Bourne Rotary Connector | | Bourne | Town of Bourne / MassDOT | 1.9 |
| **GATEWAY INTERSECTION ROADWAY IMPROVEMENTS (CASE 3A IMPROVEMENTS[1])** | | | | **2030 COST** |
| Scenic Highway to Route 25 Westbound Ramp | | | Town of Bourne / MassDOT | 11 |
| Belmont Circle Reconstruction | | | Town of Bourne / MassDOT | 23 |
| Bourne Rotary Interchange[2] | | | Town of Bourne / MassDOT | 87 |
| Route 6 Exit 1C Relocation | | | Town of Bourne / MassDOT | 51 |
| Additional Travel Lane on Route 6 Eastbound to Exit 2 | | | Towns of Bourne and Sandwich / MassDOT | 48 |
| Sagamore Bridge Approaches[3] | | | Town of Bourne / MassDOT / USACE | 64 |
| Bourne Bridge Approaches[3] | | | Town of Bourne / MassDOT / USACE | 84 |

*1 Case 3A assumes the prior replacement of the Sagamore and Bourne Bridge by the USACE.*
*2 Includes cost of Bourne Rotary Reconstruction (Alternative 2, Three Signalized Intersections).*
*3 Includes approach roadway and bridge relocation and retaining walls.*

The project development period for these projects would vary based on project complexity. Larger, more complex projects require a longer period to complete the design, environmental review and permitting, and (if required) the land acquisition process. For example, the Route 6 Exit 1C Relocation and the Scenic Highway to Route 25 westbound entrance ramp would both require extensive coordination with local utility providers to ensure uninterrupted service and safety during the relocation of their equipment (if necessary).

### *Local Intersection Improvements*

*Recommendation*

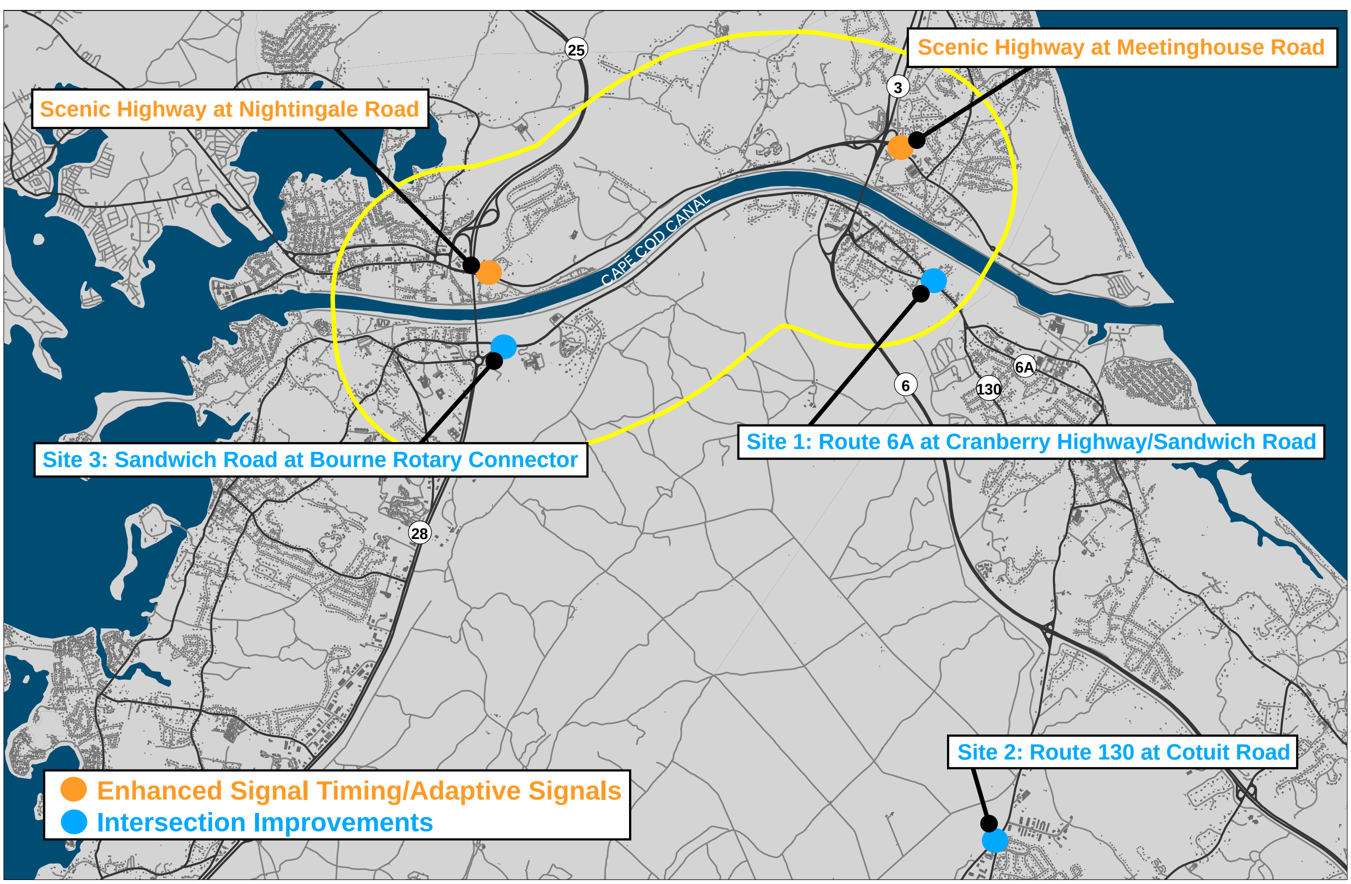
The recommended local intersection improvements include advancing several intersection improvement projects into the project development phase (Exhibits ES 25 and ES-9). These intersection improvements include:

1. **Signal timing improvements at two intersections:**
   - Scenic Highway/Meetinghouse Lane
   - Scenic Highway at Nightingale Road
2. **Intersection improvements at three intersections:**
   - Route 6A (Sandwich Road) at Cranberry Highway
   - Route 130 at Cotuit Road
   - Sandwich Road at Bourne Rotary Connector

*Benefit*

These short-term roadway improvements represent a lower-cost method to reduce congestion and improve safety at key study area intersections.

**Exhibit ES-25 Recommended Local Intersection Improvements**



## Bicycle and Pedestrian Improvements

*Recommendation*

Improve and expand bicycle and pedestrian facilities in the study area to encourage greater use of non-motorized transportation by residents and visitors.

1. **New ADA-compliant pedestrian connections to the Canal service road (bike trail) at three locations in Bourne: Bourne Ballfield, Pleasant Street, and Old Bridge Road.**

2. **Improve bicycle-pedestrian connections to/from local roadways over the Canal at Sagamore and Bourne Bridges (Exhibits ES-26 and ES-27).**

3. **Improve bicycle/pedestrian accommodation in the study area, especially along bus routes, by providing:**

    - Accessible sidewalks and crosswalks
    - Pedestrian phases at intersections
    - Shelters at bus stops
    - Bicycle racks
    - Wayfinding signage

*Top: Bicyclists on the Canal bike path road.*

*Bottom: Pedestrians and recreational fishing on the Canal.*

*Benefit*

Improved bicycle and pedestrian connections would provide more multimodal transportation options, encouraging residents and visitors to walk or bike, reducing traffic delays and congestion.

## Multimodal Transportation Center

*Recommendation*

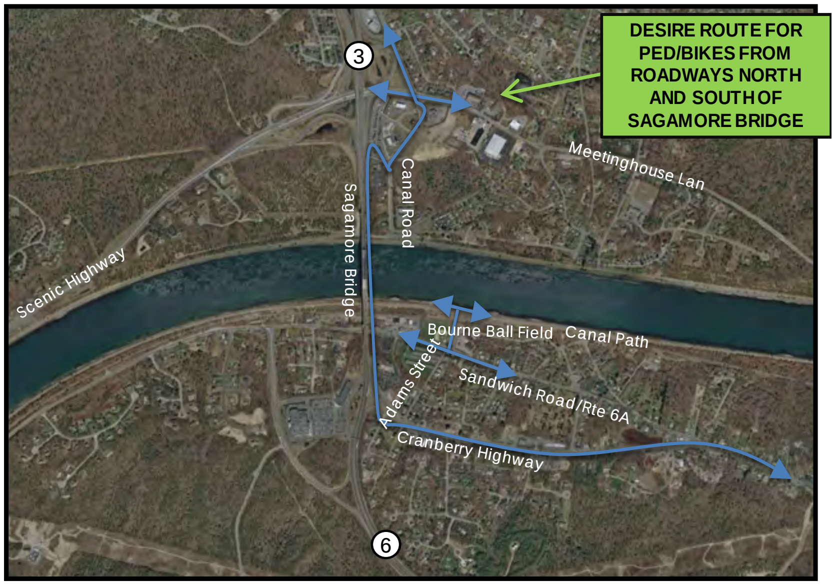
1. **Develop new Multimodal Transportation Center (with 100-space park and ride lot) at the Route 6 Exit 2 (Route 130) interchange.**

*Benefit*

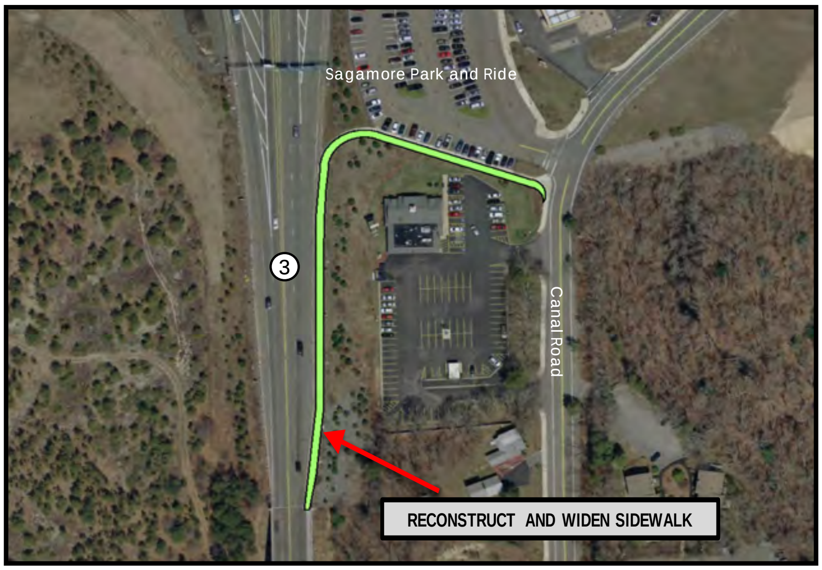
Additional park and ride facilities will encourage more travelers to use bus service and reduce single-occupancy car travel. The location of a park and ride lot at the Route 6 Exit 2 (Route 130) interchange is desirable since it is owned by MassDOT and does not contain any regulated environmental resources. Additionally, the western terminus of the upcoming Service Road shared-use path is Route 130 at this location.

*Exhibit ES-26 Enhanced Bicycle/Pedestrian Access at Sagamore Bridge*

Desired Bicycle/Pedestrian Access over Sagamore Bridge




Bicycle/Pedestrian Access over Sagamore Bridge (North of Canal)




Bicycle/Pedestrian Access over Sagamore Bridge (South of Canal)

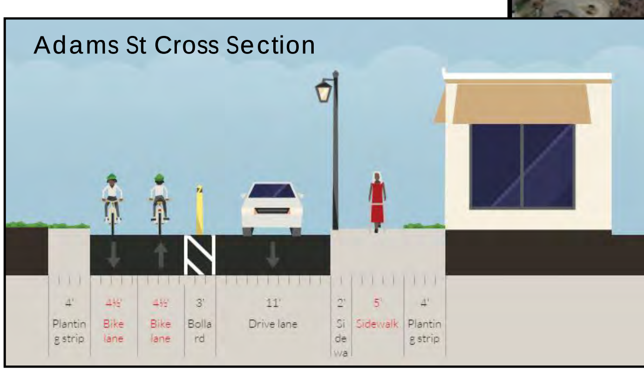
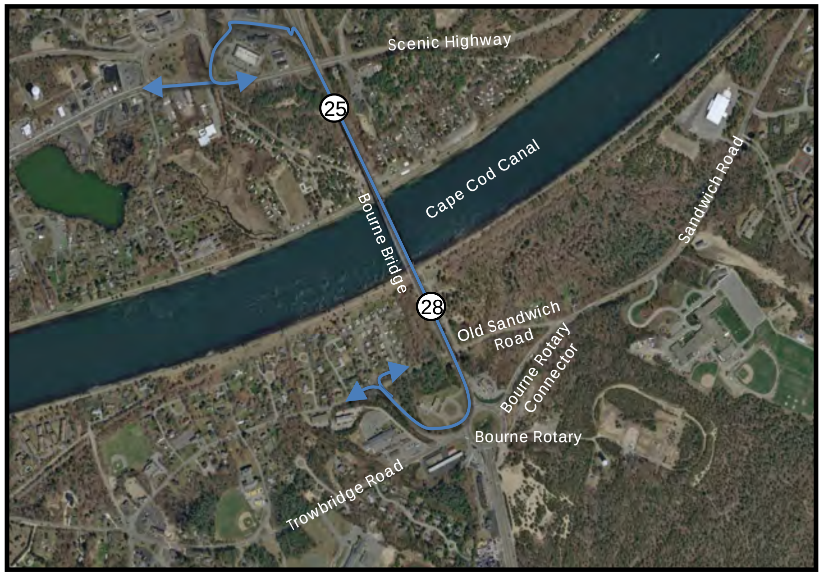



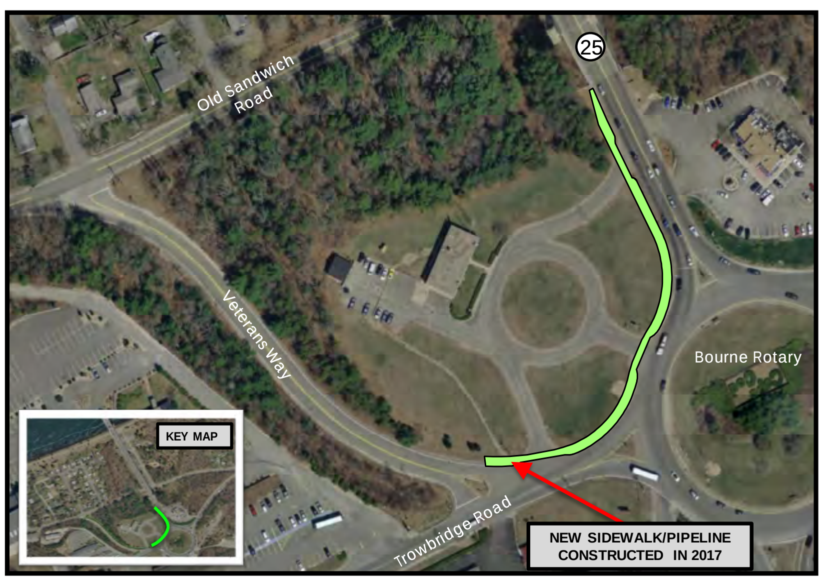
*Exhibit ES-27 Enhanced Bicycle-Pedestrian Access at Bourne Bridge*

Desired Bicycle/Pedestrian Access over Bourne Bridge




Bicycle/Pedestrian Access over Bourne Bridge (North of Canal)


Bicycle/Pedestrian Access over Bourne Bridge (South of Canal)



## NEXT STEPS

The development of transportation improvements is a complex decision-making process that involves many stakeholders, decision makers, and reviewing agencies. All projects developed by or with the involvement of the MassDOT Highway Division are guided by the eight-step process outlined in Chapter 2 of the MassDOT Highway Division's Project Development and Design Guide. This process guides a proposed transportation improvement from concept through design and construction and is designed to ensure that projects meet their stated goals and objectives.

### MassDOT Highway Design Process

This project development process is a requirement for all projects involving the MassDOT Highway Division, including projects in which the Highway Division is the project proponent, is responsible for project funding, or controls the infrastructure in question (projects on state highways). In the case of projects involving roadways or other infrastructure and property under the jurisdiction of Cape Cod municipalities, project development and implementation are the municipality's responsibility. Examples of recommendations falling under municipal jurisdiction include local roads and signalization improvements, sidewalk/ADA improvements, and other pedestrian/bicycle infrastructure.

*Working Group meetings.*

The eight major steps that constitute the MassDOT Project Development and Design Process are:

1. **Need Identification –** Define the problem, establishes project goals and objectives, and define the scope of the planning needed for implementation.
2. **Planning –** Define the existing context, confirm the project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide report documentation.
3. **Project Initiation –** MassDOT Highway Division completes a Project Initiation Form (PIF) which documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation.
4. **Public Outreach, Environmental Planning, and Right-of-Way Process –** Four distinct but closely integrated elements: Public Outreach, Environmental Documentation and **Permitting,**

Design, and Right-of-Way Acquisition. The outcome of this step is a fully designed and permitted project ready for construction.

5. **Programming (identification of funding) –** MassDOT requests that the Metropolitan Planning Organization (MPO) include a project from the Regional Transportation Plan in the region's annual Transportation Improvement Plan (TIP) development process. The cost of some of the larger the improvements recommended in this study are well beyond the level of funding the MPO typically has to allocate to projects in this region. Additional funding sources must be identified to advance these projects. The USACE would be responsible for securing federal funding for the assumed replacement of the Bourne and Sagamore Bridges.

6. **Procurement –** MassDOT Highway Division publishes a request for proposals, which is also often referred to as being "advertised" for construction. MassDOT then reviews the bids and awards the contract(s) to the qualified bidder with the lowest bid.

7. **Construction –** MassDOT Highway Division and the contractor develop a public participation plan and a temporary traffic control plan for the construction process and proceed with project construction.

8. **Assessment –** Receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects.

*Roadway construction.*

The first two steps, Needs Identification and Planning, are addressed in this study.

## Project Delivery Methods

The following sections describe three common project delivery methods for highway projects. MassDOT and the USACE would be responsible for selecting the project delivery method that best balances cost, risk, construction schedule, and inconvenience to the residents and visitors to Cape Cod.

### *Design-Bid-Build*

The project development process described previously is based on a conventional project delivery method, commonly referred to as "Design-Bid-Build" (DBB). The essence of the DBB process is that the project is designed to the 100% Plans, Specifications, and Estimates (PS&E) level and then advertised for construction. In this process the design and construction are carried out

sequentially with the engineer of record (designer) and the construction contractor as two separate contracting entities.

### *Design-Build*

The design-build (DB) project delivery process is a method to deliver a project in which the design and construction services are contracted by a single team. This process occurs after the completion of the environmental planning and 25% design phase. This type of project delivery process often takes less time than a traditional design-bid-build process because design and construction process happen at the same time.

### *Public-Private Partnership*

An infrastructure public-private partnership (P3) is generally a method of project delivery in which a private entity designs, constructs, finances, and manages a facility in exchange for a portion of the funds generated or through availability payments. In the case of a highway P3 project, the funds generated by the project are generally the tolls charged to users of the facility. A benefit of this type of project delivery process is that the project owner (in this case, MassDOT) does not have to fund the design or construction of the project.

## Environmental Considerations

This section provides a summary of the environmental documentation, review, and permitting that would need to be conducted for any alternative to be implemented. Any project will need to follow the project development design process (Step 4), which includes identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for both the Massachusetts and National Environmental Policy Acts (MEPA and NEPA). Expected environmental policy acts and permitting application and reviews are discussed below but may vary depending upon actual project design and impacts.

### *Environmental Policy Acts*

Both MEPA and NEPA require an evaluation of a range of alternatives to identify the alternative that meets the project's purpose and need with the least impact to social and natural environmental resources. Mitigation for all environmental impacts must be identified. Based on the scope of the anticipated highway improvements, it is anticipated that a MEPA review will at least consist of an Environmental Notification Form (ENF) and a Draft and Final Environmental Impact Report (EIR). Similar thresholds apply to NEPA where a full Environmental Assessment (EA) or Environmental Impact Statement (EIS) could

be warranted for this project.

### *Environmental Reviews/Permits*

Local, state, and federal regulatory agencies will review proposed activities with respect to applicable environmental laws and regulations. The following state and federal regulatory agency reviews and permits would likely be required for the recommended projects:

*State Agency Review/Approval*

- Massachusetts Environmental Policy Act (MEPA)
- Massachusetts Wetlands Protection Act (WPA) – Wetlands Notice of Intent (NOI)
- Massachusetts Division of Fisheries, Natural Heritage and Endangered Species Program review
- Massachusetts General Law Chapter 21E and the Massachusetts Contingency Plan (MCP) (hazardous materials review)

*Federal Agency Review/Approval*

- National Environmental Policy Act (NEPA)
- Section 404 Permit – U.S. Army Corps of Engineers (USACE) General Permit
- Section 401 of the Federal Clean Water Act – 401 Water Quality Certification
- Section 106 National Historic Preservation Act (managed by the Massachusetts Historical Commission (MHC))
- Endangered Species Act – Section 7 review
- Environmental Protection Agency (EPA) Construction Stormwater General Permit

## Implementation Summary

This study outlines several multimodal transportation improvement projects; all of these improvements should be considered for project development. It is imperative that municipal leadership from Bourne and Sandwich, as well as the Cape Cod Commission, area Chambers of Commerce, members of the broader community, the USACE, and MassDOT continue to coordinate and further define the most appropriate and urgent projects. In addition, continued support from local and regional stakeholders in advancing high-priority projects is critical to successfully implementing this agenda. These local priorities should inform timelines and programming for each improvement to proceed to project development.


massDOT
Massachusetts Department of Transportation



# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# CONTENTS



# EXHIBITS



# TABLES



# Introduction and Study Framework

## 1.1 INTRODUCTION

The Massachusetts Department of Transportation (MassDOT) commissioned the Cape Cod Canal Transportation Study (“the Study”) to gain a comprehensive understanding of multimodal travel within the Cape Cod Canal area — both the conditions that exist today and the forecast conditions for the future. The study identifies a series of multimodal transportation improvements that reflect the study findings and public feedback gathered as part of the study.

Cape Cod and the Islands of Martha’s Vineyard and Nantucket are major travel destinations whose recreational activities create travel demands that soar during the summer. The islands and the 15 municipalities that make up Cape Cod (Exhibit 1-1) feature beaches, golf courses, boating and fishing areas, recreation trails, historic sites, national parks, shopping areas, and restaurants. Families from New England and beyond have made Cape Cod and the Islands their preferred vacation destination for decades. For these same reasons, they have always attracted people as a place to live, to work, raise families, and retire.

The condition, capacity, and multimodal features of the Sagamore Bridge and the Bourne Bridge, the cross-Canal bridges that provide the only vehicular access to and from Cape Cod, lie at the heart the Cape's connectivity limitations. However, the configuration of approach roadways and intersections to the Canal bridges contribute to the severe congestion issues, particularly in the summer. Cape Cod also suffers from a lack of transportation options, with limited bus, transit, and pedestrian/bicycle facilities.

Cape Cod residents and visitors must often contend with substantial traffic congestion during the summer tourist season and more frequently during the fall and spring shoulder seasons. While these delays result from increased traffic demands created by an influx of visitors, the impacts of these delays—increased travel time, increased crashes, and decreased mobility—impact visitors, year-round residents, and businesses alike.

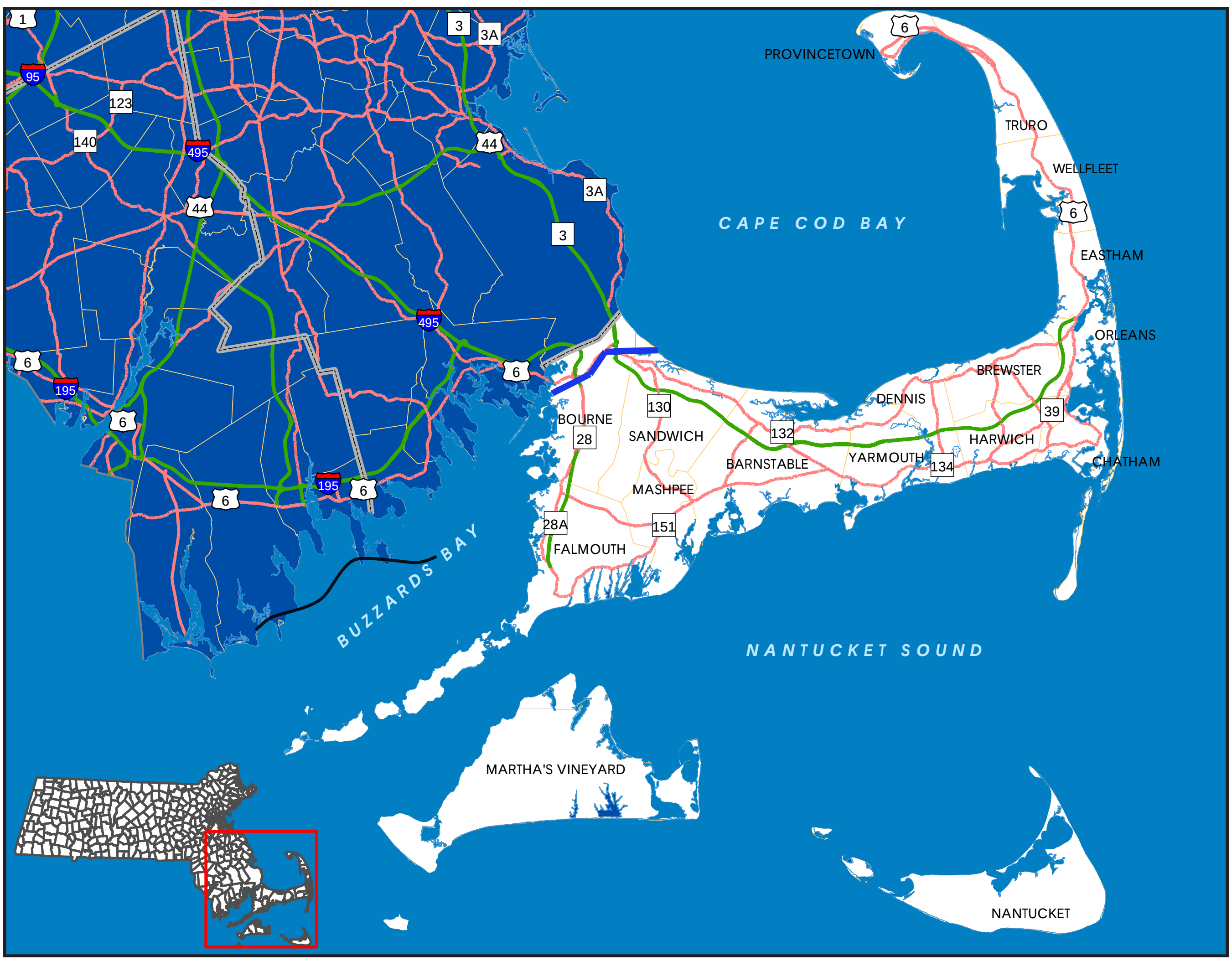
***The goal of this study is to provide reliable multimodal connectivity and mobility levels across the Canal to ensure connectivity between Bourne and Sandwich and ensure public safety in the event of an evacuation.***


MassDOT launched this study to begin addressing transportation issues surrounding the access points to Cape Cod. The study will provide recommendations for improving all transportation modes in the study area that would expand multimodal connections to protect quality of life for residents and visitors in the future.

This report comprises five main sections, each of which focuses on a study task outlined by MassDOT:

- **Task 1:** Study Area, Goals and Objectives, Evaluation Criteria, and Public Involvement Plan
- **Task 2:** Existing Environmental and Traffic Conditions
- **Task 3:** Future No-Build Conditions
- **Task 4:** Alternatives Development and Analysis
- **Task 5:** Recommendations

***Exhibit 1-1 Cape Cod, Massachusetts***



### 1.1.1 Cape Cod Canal Bridges

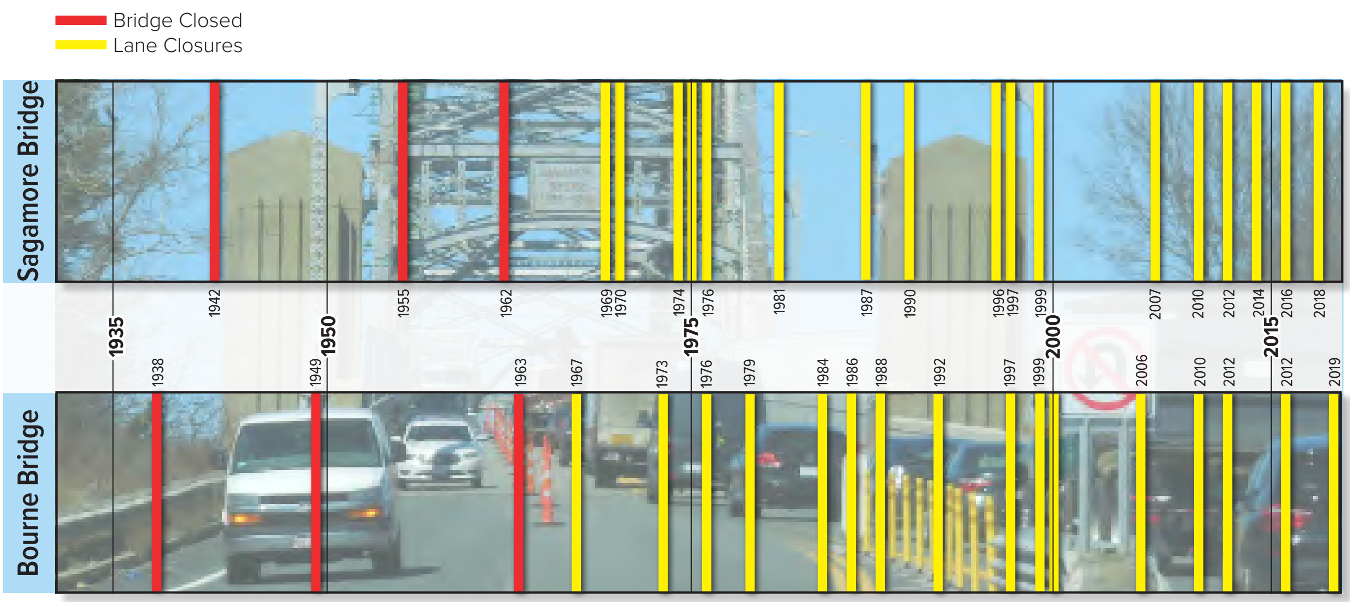
Opened in 1916, the 7-mile-long Cape Cod Canal connects Cape Cod Bay to the east and Buzzards Bay to the west. The Canal bisects the towns of Sandwich and Bourne. The bridges have been designated as eligible for individual listing on the National Register of Historic Places by the Massachusetts Historic Commission.

The U.S. Army Corps of Engineers (USACE) owns and operates the Canal and surrounding lands. Recreational and commercial vessels regularly use the Canal. These recreational and commercial vessels use the Canal extensively, passing beneath three bridges: the Bourne and Sagamore highway bridges and the Buzzards Bay Railroad Bridge.

The USACE began construction on the Sagamore and Bourne bridges in 1933 and both opened on June 22, 1935. Like the Canal, the two highway bridges and the railroad bridge are owned and operated by the USACE. Identical in design, each highway bridge is approximately 48-feet in width providing four 10-foot-wide traffic lanes (two lanes in each direction), with no roadway shoulder and a single five-foot wide sidewalk with 2 foot safety walk on the opposite side. The sidewalks are on the east side of the Sagamore Bridge and the west side of the Bourne Bridge.

The design of the bridges is substandard in several ways: lane widths are too narrow, there are no roadway shoulders, and bicycle and pedestrian accommodations are minimal. At more than 80 years old, the bridges have exceeded their design life and require substantial regular maintenance to function reliably. Since 1990, they have needed more frequent maintenance that

## Bourne & Sagamore Bridge Maintenance History




often requires closing a travel lane in the off-season (as shown on the figure above). While necessary, these lane closures cause substantial delay and are disruptive to the local communities.

Due to the condition and age of the bridges, the USACE is currently conducting a 'Major Rehabilitation Study' of both bridges. The outcome of this study will be a determination to either continue long-term maintenance of the bridges or to replace them.

Chapter 2 describes the existing transportation facilities, land uses, socio-economic conditions, and environmental resources in the study area.

## 1.2 STUDY CONTEXT

This study focuses on transportation issues in the communities in the upper Cape Cod Canal area, including Bourne, Plymouth, Sandwich, and Wareham. However, the impact of these issues extends to all of Cape Cod (Barnstable County), Nantucket County, and Dukes County (Martha's Vineyard and the Elizabeth Islands). Portions of both Bourne and Sandwich are north of the Cape Cod Canal.

This study represents an initial step toward improving the transportation system in the study area. The study aims to:

- build a clear understanding of the existing transportation system, including operational and crash characteristics and projected future conditions at key locations;
- identify roadway locations with substantial operational and/or safety problems; and
- evaluate and provide recommendations, as appropriate, for other forms of transportation, including freight, transit, pedestrian, and bicycle facilities.

While this study makes recommendations for improving multimodal transportation, these recommendations represent only a first step toward solving these problems. Next steps include a thorough evaluation of potential improvements through state and federal environmental analysis, under the processes created by the National Environmental Policy Act (NEPA) and the Massachusetts Environmental Policy Act (MEPA).

These processes ensure that potential improvements undergo public review. They also ensure that a thorough comparison of alternatives is performed to test a project's ability to meet established purposes and needs, measure and minimize social and natural environmental impacts, and evaluate costs. When these processes end, recommended improvements undergo advanced engineering design and are programmed for funding through coordination with local metropolitan planning organizations, the USACE, and MassDOT.

## 1.3 STUDY AREA

Exhibit 1-2 shows the study area and a focus area. The study area includes land up to four miles on either side of the Canal, extending further at certain points to include major highway interchanges. From the northeast, the study area extends from the Route 3 Exit 2/Herring Pond Road interchange in Plymouth south over the Sagamore Bridge, to the Route 6 Exit 2/Forestdale Road interchange in Sandwich. From the northwest, the study area extends from the Route 25/I-195 interchange in Wareham south, over the Bourne Bridge, to Route 151 in Bourne.

***Cape Cod generally refers to all land within the 15 communities east of the Cape Cod Canal. Barnstable County consists of the same 15 communities, but portions of Bourne and Sandwich lie west of the Canal. Therefore, Barnstable County is slightly larger than Cape Cod in both land area and population***

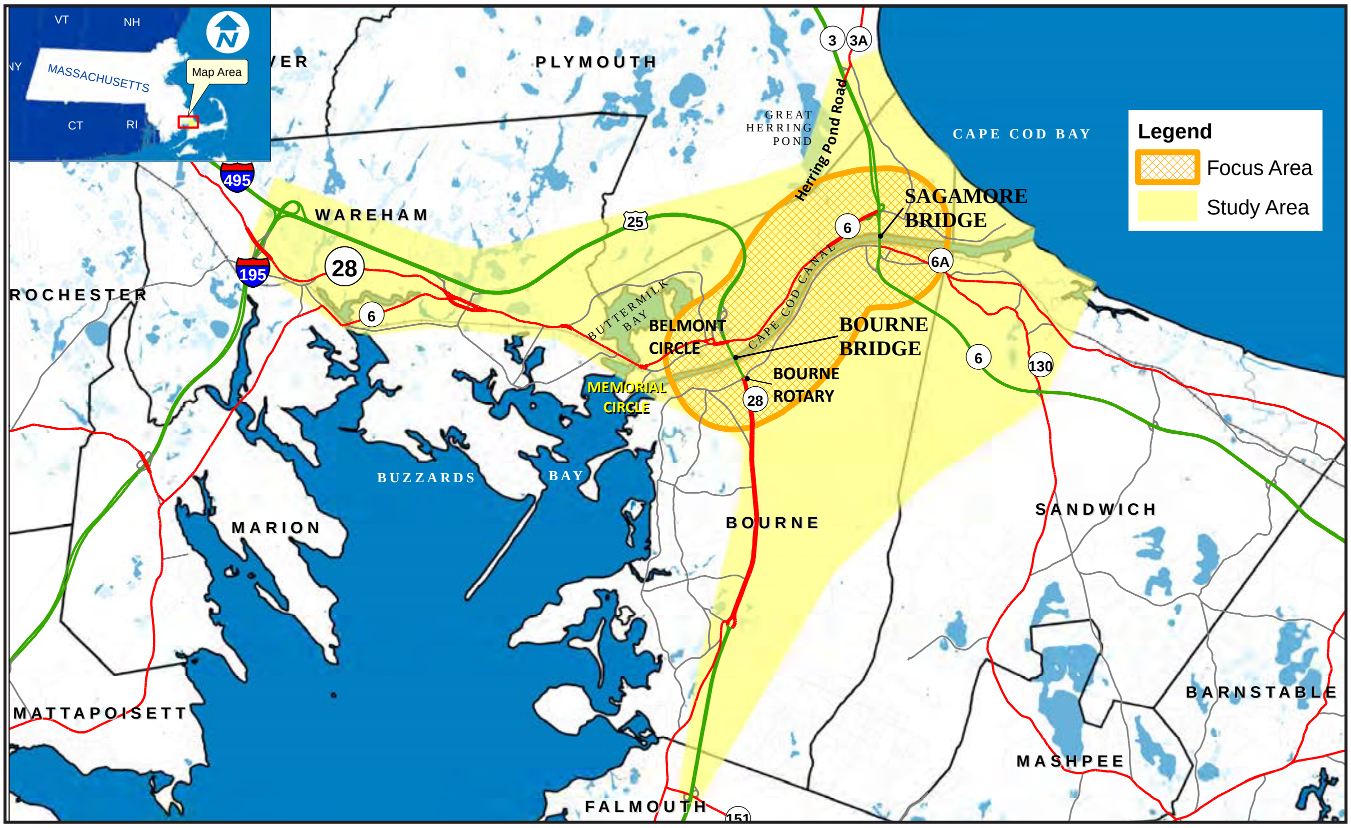



***Exhibit 1-2 Study Area/Focus Area***

The focus area extends approximately one mile north and south of the Canal. To gain a thorough understanding of the issues and constraints within the study area, information related to environmental resources, socio-economic data, and traffic was gathered for this study area. More detailed data collection and analysis occurred within the focus area where most proposed transportation improvements would likely occur.

## 1.4 GOALS AND OBJECTIVES

The study's goals and objectives were developed, and revised as necessary, by MassDOT in cooperation with the study Working Group and shape the framework of the entire study. All transportation improvements recommended in this study seek to fulfill the following goals and objectives.

### 1.4.1 Goals

- Improve transportation mobility and accessibility in the Cape Cod Canal area and provide reliable year-round connectivity over the Canal and between the Sagamore and Bourne Bridges.

### 1.4.2 Objectives

- Improve multimodal connectivity and mobility across the Canal to avoid degrading quality of life on the Cape.
- Ensure that cross-Canal connectivity does not become a barrier to reliable intra community travel within Bourne and Sandwich.
- Create a reliable multimodal connection across the Canal to assure public safety in the event of an emergency evacuation of portions of the Cape and accommodate first responders trying to reach the Cape.

The study area definition, goals and objectives, and evaluation criteria (Table 1-1) were presented to the project's Working Group in November 2014 and to the public at the study's first public meeting in January 2015.

## 1.5 EVALUATION CRITERIA

Chapter 4, Alternatives Development and Analysis, documents how potential transportation improvements perform against Transportation Improvement Evaluation Criteria (Table 1-1). These criteria were developed with the aim of advancing the study's goals and objectives (Section 1.4). As appropriate, the study team derived individual criteria directly from either existing data or analytical techniques used in this study. All these criteria—both quantifiable and qualitative measures of effectiveness—helped identify the solutions that best matched the goals and objectives.

## 1.6 PUBLIC INVOLVEMENT PLAN

Public involvement played a key role in this study, following the steps outlined in a "Public Involvement Plan" (Appendix A). Developed at the initiation of the study, the involvement plan guided the study team's efforts to elicit detailed and

*Working Group meeting, Bourne March 10, 2016*

*Table 1-1 Transportation Improvement Evaluation Criteria*

| | |
|---|---|
| **TRANSPORTATION** | |
| Vehicles | Corridor intersections level of service (LOS) |
| | Corridor volume-to-capacity ratios |
| | 50th- and 95th-percentile queues |
| Pedestrian and bicycle | Mobility and connectivity |
| | Bicycle/pedestrian delay |
| | Expansion/Provision of bicycle facilities |
| | Expansion/Provision of pedestrian facilities |
| Travel time | Average roadway travel time along corridor |
| | Average roadway delay |
| **SAFETY** | |
| Vehicular safety | Conformance with AASHTO and MassDOT standards |
| | Delay to emergency vehicle access |
| Pedestrian and bicycle safety | Compliance with ADA requirements |
| | Compliance with MassDOT requirements |
| **ENVIRONMENT** | |
| Environmental impacts | Impact on coastal resources (sq. ft.) |
| | Impact on wetland resources (sq. ft.) |
| | Impact on Areas of Critical Environmental Concern (ACEC) |
| | Impact on rare species/habitat |
| | Impact on public water supply |
| **COMMUNITY** | |
| Community impacts | Impact on protected and recreational open space |
| | Impact on public health |
| | Impacts on Environmental Justice neighborhoods |
| | Impact on historical/archaeological resources |
| Visual | Visual impacts |
| **LAND USE AND ECONOMIC DEVELOPMENT** | |
| Property or business impacts | Impact to residential or commercial property |
| | Impact to access to commercial property |
| **FEASIBILITY** | |
| Cost | Capital costs |
| Construction phase impacts | Construction duration |
| | Impacts on abutting land owners |
| | Impacts on marine traffic |
| | Impacts on vehicular traffic |
| Right-of-way impacts | Permanent and temporary right-of-way impacts |

***The Public Involvement Plan allows the public to contribute to the study in a meaningful way throughout the study.***

comprehensive comments from the public and to build agreement and support for the study recommendations.

Fully aligned with MassDOT's Accessible Meeting Policy Directive, the Public Involvement Plan, guided citizen engagement by emphasizing these principles:

1. **Public Engagement** – The study offered multiple channels for members of the public to learn about or participate. These included public informational meetings, Working Group meetings, a study website, and media outreach. The public and the Working Group received advance notice of meeting times, and MassDOT worked diligently to hold meetings at convenient times and in convenient, comfortable, and accessible places. Meeting notices appeared on the project website, in e-mail notifications, and in local newspapers.

2. **Public Participation** – There were many opportunities for members of the public to participate in the study. The study team recorded all questions from members of the public or the Working Group, whether raised in a meeting or by e-mail or letter and answered them in a timely manner. The study team coordinated and encouraged collaboration among agencies and community organizations with the aim of providing members of the public the most up-to-date and accurate information possible.

3. **Access to Study Information** – The public had, and continues to have, access to information about the study through the study website: (www.mass.gov/cape-cod-canal-transportation-study). Records include all public information and all Working Group presentations, agendas, summaries, and handouts. Community libraries in the study area received printed copies of this report. The study team developed a stakeholder mailing list for distributing e mail. These messages provided notices of website updates, meeting dates and times, media notices, and project documents.

4. **Accessible Documents** – All information posted on the study website appears in an electronic format accessible to people with disabilities in compliance with Section 508 of the U.S. Rehabilitation Act of 1973, the Massachusetts General Law Chapter 272 Section 98/98A, and Web Content Accessibility Guidelines (WCAG 2.0).

5. **Clear Information** – Information provided to the public, including technical terms and regulatory procedures, has been presented in a clear, concise, and understandable manner.

### 1.6.1 Working Group

A Working Group guided the planning process for identifying transportation improvements in the study area. MassDOT invited members of stakeholder interest groups to join the Working Group. The Working Group, shown in Table 1-2, includes local and state elected officials and representatives from federal and state agencies, area municipalities, metropolitan planning organizations, chambers of commerce, key businesses, and other interested parties. The study team worked closely with the Working Group, sharing relevant study documents as they became available.

Working Group members provided advice and insight on local issues, helped to identify deficiencies in the transportation network, and helped develop and then assess improvement alternatives and their impacts. Feedback from the Working Group allowed continuous refinement of the alternatives under consideration.

Members of the Working Group identified issues important to members' interests and communities, and members served as liaisons to their respective organizations or communities.

*Table 1-2 Invited Members of the Study Working Group*

- *State and Local Elected Officials*
- *Cape Cod Commission*
- *Army Corps of Engineers*
- *Federal Highway Administration*
- *Joint Base Cape Cod*
- *U.S. Coast Guard*
- *Wampanoag Tribes of Aquinnah and Mashpee*
- *Massachusetts State Police*
- *Massachusetts Bay Transportation Authority (MBTA)*
- *Massachusetts Maritime Academy*
- *Massachusetts Department of Environmental Protection*
- *Massachusetts Office of Coastal Zone Management*
- *Massachusetts Historical Commission*
- *Massachusetts Division of Marine Fisheries*
- *Massachusetts National Heritage and Endangered Species Program*
- *Massachusetts Division of Energy Resources*
- *Southeastern Regional Planning and Economic Development District (SRPEDD)*
- *Old Colony Planning Council*
- *Cape Cod Canal Area Traffic Task Force*
- *Cape Cod Regional Transit Authority*
- *Greater Attleboro Taunton Regional Transit Authority (GATRA)*
- *Local and Regional Chambers of Commerce*
- *Barnstable County Commission*
- *Representatives from Bourne, Sandwich, Plymouth and Wareham*
- *Woods Hole, Martha's Vineyard & Nantucket Steamship Authority*
- *Regional Commercial Bus Lines*
- *Association for Preservation of Cape Cod*
- *Representatives from Canal Area Neighborhoods*

### 1.6.2 Working Group/Public Meetings

The study team held eleven Working Group and four public meetings between October 2014 and February 2019 (Table 1-3). These meetings were primarily held at the Massachusetts Maritime Academy in Bourne, the Bourne Public Library, and the Sandwich Town Hall.

*Table 1-3 Public Involvement Meetings*

| DATE | LOCATION |
|---|---|
| **WORKING GROUP MEETING #1** | |
| October 29, 2014 | Upper Cape Cod Regional Technical School, Bourne |
| **CAPE COD COMMISSION** | |
| January 14, 2015 | Cape Cod Commission Office, Barnstable |
| **PUBLIC INFORMATION MEETING #1** | |
| January 15, 2015 | Massachusetts Maritime Academy, Bourne |
| **WORKING GROUP MEETING #2** | |
| April 2, 2015 | Massachusetts Maritime Academy, Bourne |
| **PUBLIC INFORMATION MEETING #2** | |
| April 16, 2015 | Massachusetts Maritime Academy, Bourne |
| **WORKING GROUP MEETING #3** | |
| September 10, 2015 | Sandwich Town Hall |
| **CAPE COD COMMISSION** | |
| March 3, 2016 | Cape Code Commission Office, Barnstable |
| **WORKING GROUP MEETING #4** | |
| March 10, 2016 | Bourne Community Building, Bourne |
| **WORKING GROUP MEETING #5** | |
| July 26, 2016 | Massachusetts Maritime Academy, Bourne |
| **WORKING GROUP MEETING #6** | |
| September 28, 2016 | Massachusetts Maritime Academy, Bourne |
| **PUBLIC INFORMATION MEETING #3** | |
| December 1, 2016 | Massachusetts Maritime Academy, Bourne |
| **WORKING GROUP MEETING #7** | |
| January 26, 2017 | Bourne Public Library |
| **WORKING GROUP MEETING #8** | |
| June 29, 2017 | Sandwich Town Hall |
| **WORKING GROUP MEETING #9** | |
| December 14, 2017 | Sandwich Town Hall |
| **WORKING GROUP MEETING #10** | |
| February 1, 2018 | Sandwich Town Hall |
| **WORKING GROUP MEETING #11** | |
| August 1, 2018 | Massachusetts Maritime Academy, Bourne |
| **CAPE COD COMMISSION/CAPE COD METROPOLITAN PLANNING ORGANIZATION JOINT MEETING** | |
| February 21, 2019 | Barnstable County Complex, Barnstable |
| **PUBLIC INFORMATION MEETING #4** | |
| February 13, 2019 | Massachusetts Maritime Academy, Bourne |

### 1.6.3 Outreach to Environmental Resource Agencies

The study team met with representatives of the Massachusetts Division of Fisheries and Wildlife (DFW) to review the parameters of the project and discuss rare species in the study area. DFW discussed the potential sensitivity of northern long-eared bat (designated by the US EPA as a threatened species) and the New England cottontail rabbit.

A formal request for information about the presence of rare, threatened, or endangered species was submitted to the Massachusetts Natural Heritage and Endangered Species Program in December 2016.

### 1.6.4 Outreach to Tribes

The study team held an informational meeting during summer 2015 with representatives of the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head (Aquinnah). The team presented the overall goals and parameters of the study to tribal representatives. The team also provided a description and mapping of potential transportation improvements to the Mashpee Wampanoag Tribe.

The study team has also held discussions with the Herring Pond Wampanoag Tribal Council about the study goals and potential transportation improvements. The Tribal Council relayed its concerns and identified locations members considered to have cultural significance.

### 1.6.5 Project Website

MassDOT has created and maintained a study website. The website, found at [https://www.mass.gov/cape-cod-canal-transportation-study](https://www.mass.gov/cape-cod-canal-transportation-study), provides information about the study including an overview of the purpose of the study, contact information to provide any study-related questions or comments, and public meeting information. For each Working Group or public meeting held, the website provides a copy of the meeting agenda, the PowerPoint presentation, and the meeting notes.

All information posted on the study website is provided in an electronic format accessible to those with disabilities in compliance with Section 508 of the U.S. Rehabilitation Act of 1973, Massachusetts General Law Chapter 272 Section 98/98A and the Web Content Accessibility Guidelines (WCAG 2.0).

massDOT
Massachusetts Department of Transportation

# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# CONTENTS

# EXHIBITS

# TABLES




# Existing Environmental and Traffic Conditions

This chapter provides a review of existing conditions in the study area including roadway and multimodal facilities, natural and social environmental resources, and socio-economic conditions. These data informed the design constraints and provide a basis for the evaluation criteria. Next, existing and future traffic volumes in the study area were modeled to create a future (2040) 'no build' alternative which serves as the baseline for the comparison of future transportation improvements.

## 2.1 EXISTING ENVIRONMENTAL CONDITIONS

A survey of existing conditions and trends in the study area shapes a broad understanding of the transportation systems and important environmental resources that any transportation initiative should, if possible, avoid disrupting.

The Cape Cod Canal study area is home to abundant natural, cultural, and recreational resources. This includes unique ecological systems and habitats, including wetlands and

waterways, and valuable cultural assets such as park systems, archaeological sites, and historic landmarks and districts.

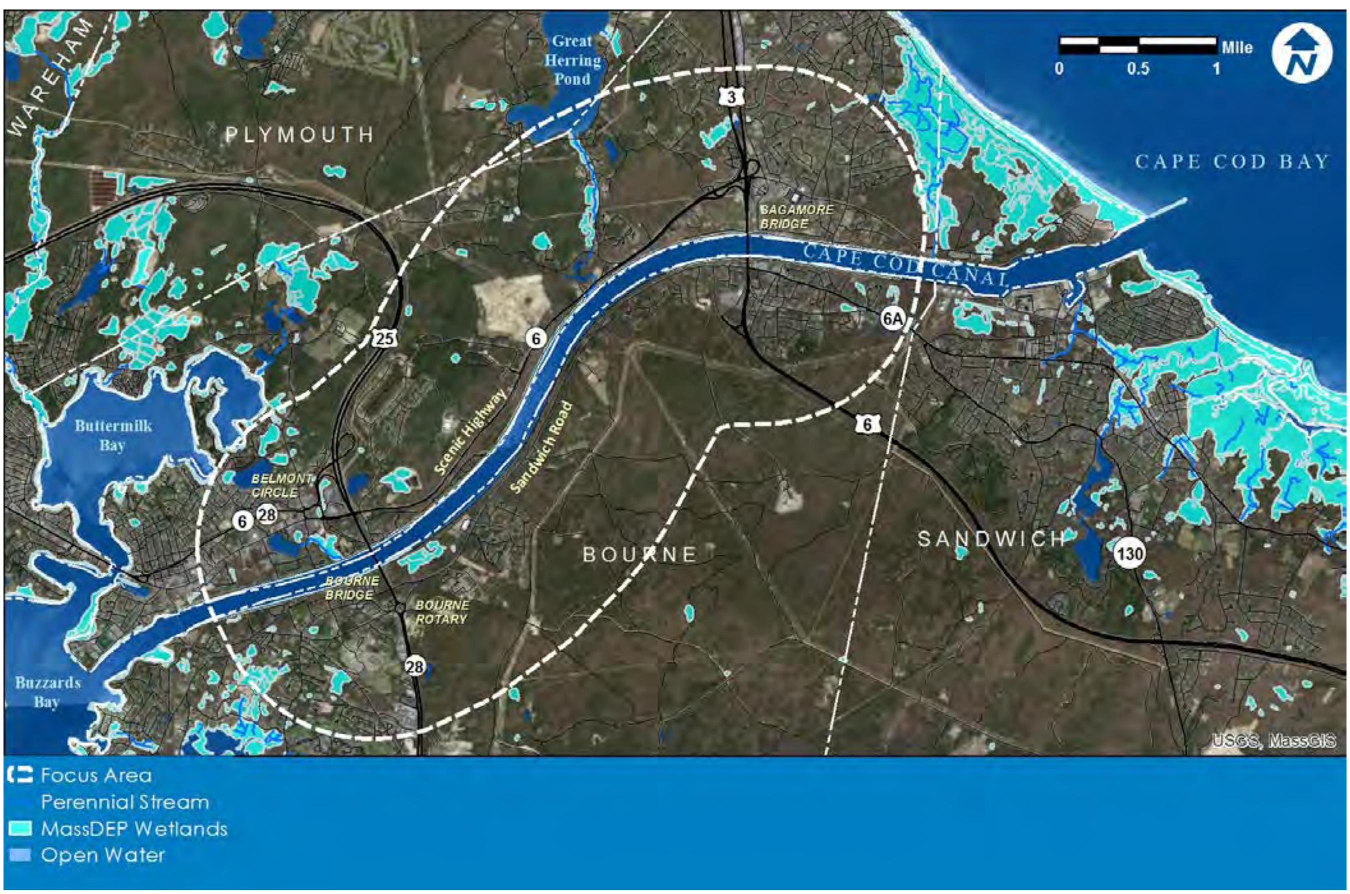
Federal, state, and local laws and regulations—including the federal Clean Water and Endangered Species Acts, the state Wetlands Protection Act (WPA), and municipal wetland ordinances—protect natural wetland, water, and wildlife resources from impact. Similarly, cultural resources such as historic sites and open space receive protection under laws such as the National Historic Preservation Act and Section 4(f) of the DOT Act of 1966.

### 2.1.1 Wetland, Floodplain, and Surface Waterbodies

Based on information gathered from the MassGIS database, wetland resources in the study area (Exhibit 2-1) include extensive coastal resources both north and south of the Canal, wetlands bordering the Herring River, and scattered wetlands north of Buttermilk Bay. Additional open water wetlands include the Cape Cod Canal, Great Herring Pond, Buttermilk Bay, and smaller waterbodies.

The wetland resources at the east end of the Canal represent the largest extent of wetlands in the study area. Floodplains, as designated by the Federal Emergency Management Agency

***Exhibit 2-1 Wetlands and Surface Waterbodies***



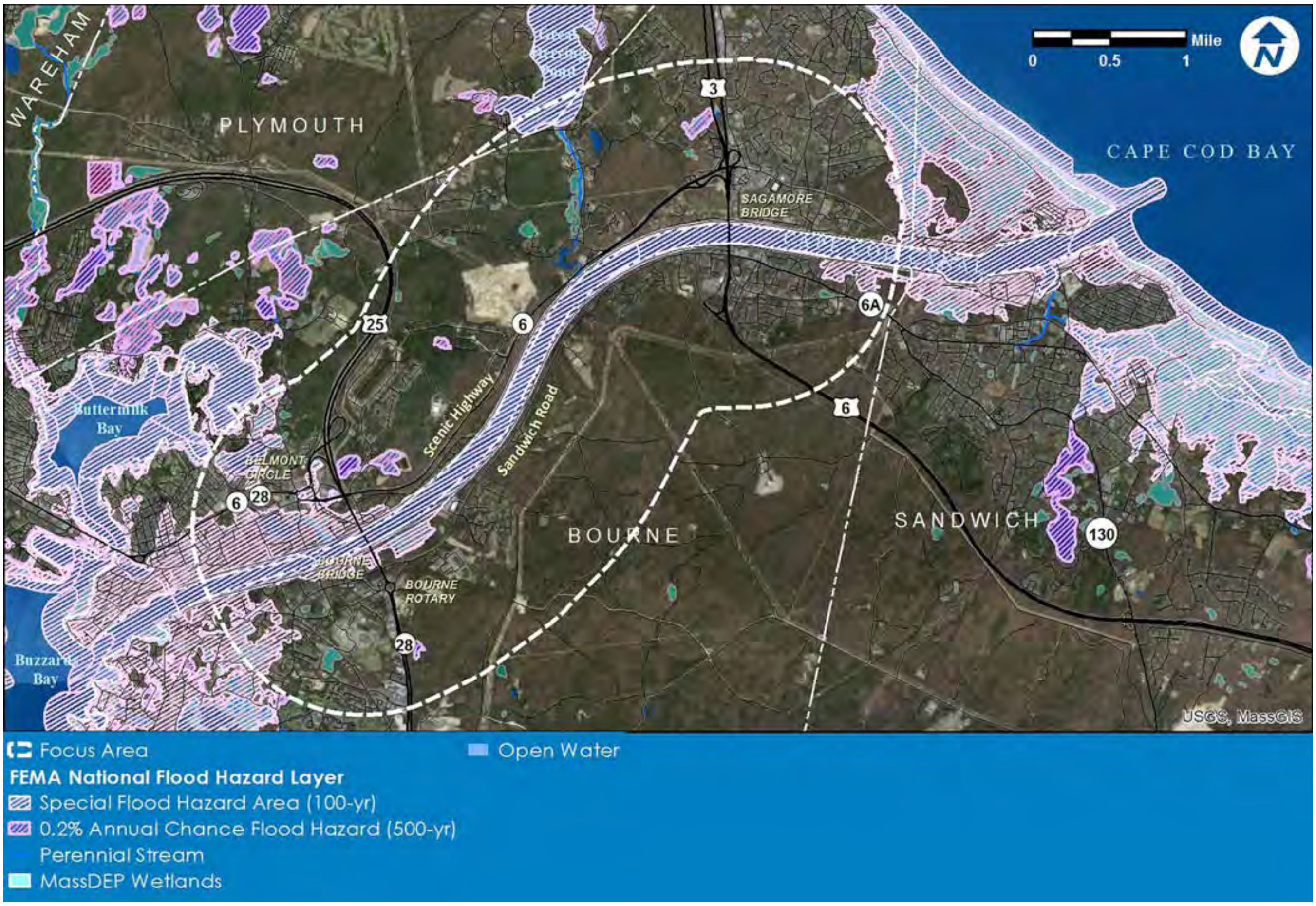



***Exhibit 2-2 FEMA Floodplains***

(FEMA), exist both north and south of the Canal in nearly the same areas as the wetlands (Exhibit 2-2). The one exception comprises areas in Bourne designated as 100-year floodplains that extend north of the Canal beyond Main Street to the Buzzards Bay Bypass. Areas immediately south of the Canal in Bourne are also designated as 100 year floodplains.

### 2.1.2 Aquifers and Public Water Supply Wells

An aquifer is an underground layer of rock containing water that can easily move within the layer. Wells provide access to this water for personal uses such as drinking, cooking, and showering, as well as for agricultural use. Exhibit 2-3 (next page) identifies state-designed buffers around drinking-water supply wells (known as Zone II areas and Interim Wellhead Protection Areas (IWPA)).

Protection of aquifers is particularly important because the study area sits atop a designated "sole-source aquifer" that includes all of Barnstable County, the towns of Plymouth and Wareham, and portions of Kingston, Plympton, and Carver.

Under the federal Safe Drinking Water Act, an aquifer qualifies as "sole source" if it provides at least 50% of the drinking water for


*Exhibit 2-3 Aquifers and Public Water Supply Wells*

its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated.

### 2.1.3 Fisheries and Shellfish Growing Areas

Commercial fishing and shellfishing are key economic activities on Cape Cod and important parts of its history and culture. While there are eight commercial fishing harbors on the Cape only the East Canal Entrance Harbor is within the study area (Exhibit 2-4). Fish species commonly landed by commercial fishermen on Cape Cod include black sea bass, striped bass, bluefin tuna, bluefish, cod, dogfish, flounder, monkfish, and skate. Shellfish (mollusks and crustaceans) species commonly landed include lobster, mussels, sea scallops, bay scallops, and conch.

Shellfishing also occurs in the Cape Cod Canal, Buttermilk Bay, and Buzzards Bay. Shellfishing areas are regularly evaluated through sanitary surveys to confirm whether or not harvested shellfish are safe for human consumption. Based on the sanitary survey shellfish areas are assigned one of five categories.

1. **Approved:** Open to shellfish harvesting for direct human consumption.

2. **Conditionally Approved**: Closed some of the time due to rainfall or seasonally poor water quality or other predictable events.

3. **Restricted:** Contains a limited degree of contamination at all times. When open, shellfish can be relayed to a less contaminated area or harvested for depuration.

4. **Conditionally Restricted:** Contains a limited degree of contamination at all times. Subject to intermittent pollution events and may close due poor water quality from rainfall events or season.

5. **Prohibited:** Closed to the harvest of shellfish under all conditions.

As shown on Exhibit 2-4, shellfishing is approved in most of Buzzards Bay and Buttermilk Bay and the central portion of the Canal. Shellfishing is prohibited at both the eastern and western ends of the Canal.

***Exhibit 2-4 Fisheries and Shellfish Growing Areas***

*(top to bottom)*
*Fishing on Cape Cod Canal*

*Roseate Tern – federally listed endangered species*

*Diamondback Terrapin – state listed threatened species*

Recreational fishing and shellfishing are also important parts of the Cape's history and culture. Chartering a fishing boat for the day or fishing from the banks of the Canal for striped bass and sea bass is a popular activity for residents and visitors alike.

The Canal area is also home to several anadromous fish species, including alewife and blueback herring. These fish spend most of their lives in the ocean but migrate up the Herring River or Mill Creek to lay their eggs in Great Herring Pond or Shawme Lake.

### 2.1.6 Rare, Threatened, and Endangered Species

Extensive areas both north and south of the Canal contain rare-species habitat (Exhibit 2-5). Specifically, the Massachusetts Natural Heritage and Endangered Species Program (MNHESP) has designated these areas as either Estimated Habitats of Rare Wildlife or Priority Habitats of Rare Species.

The MNHESP provided a list of state-designated rare, threatened, or endangered species in the study area (see Appendix B). These species include a wide variety of turtles, reptiles, birds, butterflies, moths, mussels, and plants. Numerous certified and potential vernal pools also exist throughout the study area.

Any proposed work within rare species habitats will require coordination with MNHESP, generally as part of the WPA Notice of Intent process, to ensure there is no significant impact to these rare species (known as a "take"), requiring the development of a Conservation Management Plan.

The federally-listed species known to occur in the study area include the piping plover, roseate tern, and red knot (all bird species), the red bellied cooter turtle, the sandplain gerardia (flower), the northeastern red tiger beetle, and the northern long-eared bat.

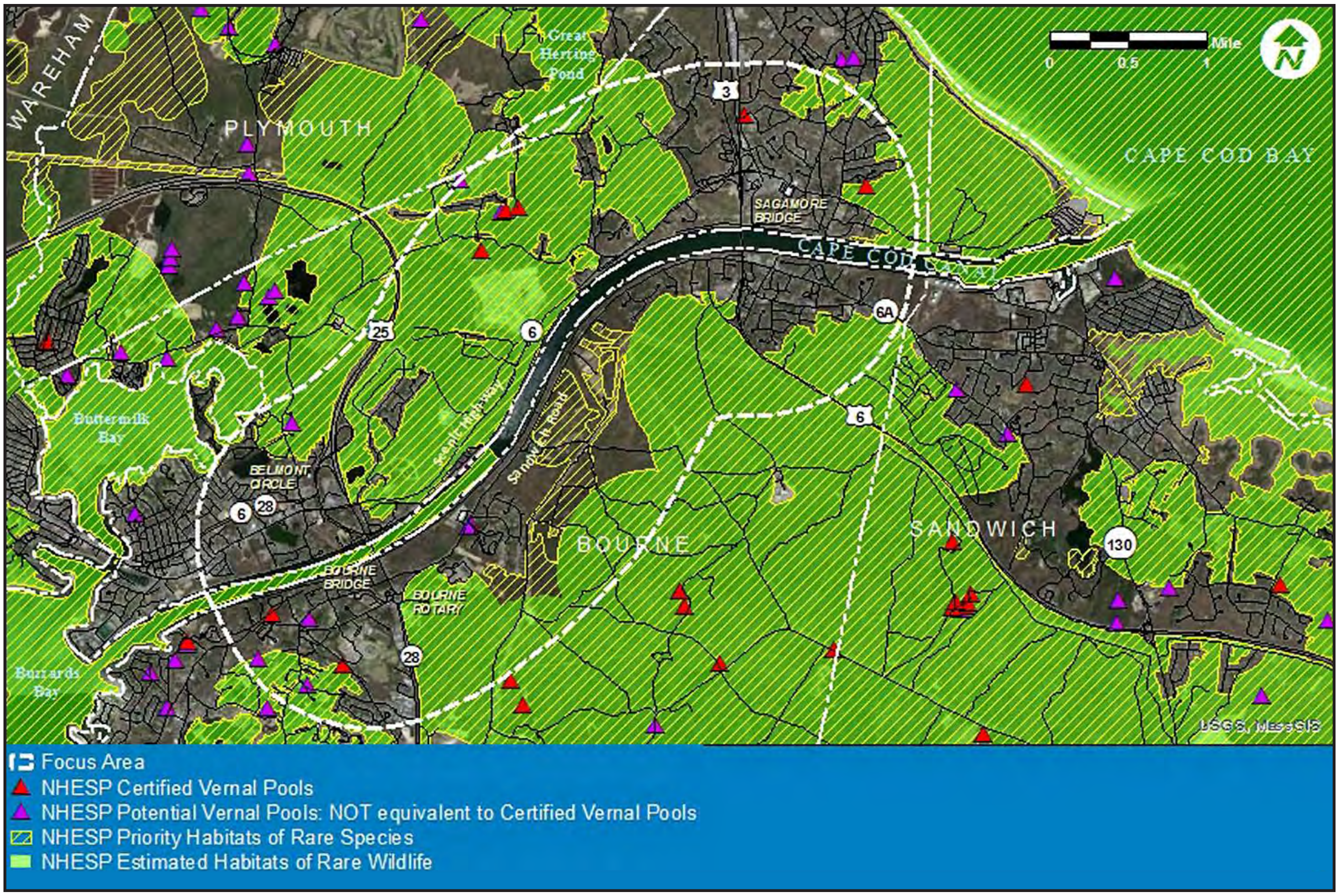



***Exhibit 2-5 Rare, Threatened, and Endangered Species***

***Exhibit 2-6 Areas of Critical Environmental Concern***

### 2.1.7 Areas of Critical Environmental Concern

The study area contains two state-designated Areas of Critical Environmental Concern (ACECs): the Bourne Back River and the Herring River (Exhibit 2-6). ACECs are places in Massachusetts that receive special recognition because of the quality, uniqueness, and significance of their natural and cultural resources. These areas are identified and nominated at the community level, then are reviewed and designated by the state's Secretary of Energy and Environmental Affairs (EEA). The ACEC program is administered by the Department of Environmental Protection on behalf of the EEA Secretary.

The 1,850-acre **Bourne Back River ACEC** in Bourne was designated an ACEC in 1989. It contains outstanding natural resources including marshes, tidal flats, and freshwater wetlands. Because these resources occur within an unaltered and undeveloped area, they function at their maximum capacity as habitats, nurseries, spawning grounds, and in the case of barrier beaches, storm-protection barriers. The estuarine/saltmarsh ecosystem, including headwater wetland areas, supports a wide variety of shellfish, finfish, amphibians, reptiles, birds, and mammals within an extraordinary spectrum of habitat types. The area contains at least three known state-listed rare and endangered species, including osprey, spotted turtle, and diamondback terrapin.

The **Herring River ACEC** in Bourne and Sandwich received ACEC designation in 1990. At 4,450 acres, it contains eleven lakes and ponds (the largest, Great Herring Pond, is 376 acres), numerous freshwater wetlands, productive cranberry bogs, and more than 250 acres of protected open space. The area contains one of the most important anadromous fish runs along the Southeastern Massachusetts coast and Great Herring Pond supports a regionally important freshwater recreational fishery. The area lies within the Plymouth-Carver Sole Source Aquifer and is critical to public water supply. At least three known state-listed rare and endangered species, including the box turtle and spotted turtle, are present.

### 2.1.8 Oil and Hazardous Materials Sites

Oil and hazardous-material release sites exist in the study area, including active Massachusetts Department of Environmental Protection (MassDEP) Chapter 21E sites, sites with an approved Activity and Use Limitation (AUL, as shown on Exhibit 2-7), and Superfund sites.

MassDEP Chapter 21E sites are sites that have been reported to MassDEP and have been issued a tier classification for the presence of oil and/or hazardous materials. The study area

contains sites classified as either Tier ID or Tier II. A site is classified as Tier ID if the responsible party has not met MassDEP reporting requirements. A site is classified as a Tier II site when the hazardous releases do not pose an imminent hazard, involve groundwater contamination, or threaten drinking water supplies.

AULs provide notice that oil and/or hazardous material contamination remains at the location after a cleanup. The AUL is a legal document that identifies activities and uses that may and may not occur on the property, as well as the owner's obligation and maintenance conditions that must be followed to ensure the safe use of the property.

Exhibit 2-7 also identifies the transfer stations in Bourne and Sandwich and the Superfund site at Joint Base Cape Cod, which is described in more detail below.

Superfund sites are locations contaminated with hazardous substances and pollutants that have designated by the U.S. Environmental Protection Agency for cleanup.

The Otis Air National Guard Base (ANGB)/Joint Base Cape Cod (JBCC) is a federal facility that was placed on the National

***Exhibit 2-7 Oil and Hazardous Materials Sites***

Priorities List as a Superfund site in 1989. The site covers more than 20,000 acres in the towns of Bourne, Falmouth, Mashpee, and Sandwich. The site contains multiple plumes of contaminated groundwater that are undergoing active remediation to protect the Cape's federally-designated sole source aquifer (source of drinking water for 200,000 year-round and 500,000 seasonal residents). Contamination sources include fuel spills, training, disposal, and other past activities at Otis ANGB/JBCC.

Two environmental cleanup programs at the JBCC address groundwater contamination and its sources. One program under the Superfund program is managed by the U.S. Air Force and focuses on contamination found primarily at Otis ANGB on the southern portion of the JBCC. The other, managed by the U.S. Army, addresses contamination from Camp Edwards, the northern portion of the base, under the Safe Drinking Water Act. Both of these programs operate under oversight of the U.S. Environmental Protection Agency and the MassDEP.

### 2.1.9 Upper Cape Water Supply Reserve

The Upper Cape Water Supply Reserve (Reserve) is the northern 15,000 acres of JBCC (Exhibit 2-8). The Reserve, owned by the Commonwealth, serves two purposes:

1. It is New England's largest military training center serving soldiers from the Massachusetts Army National Guard and numerous other military branches. The Reserve provides facilities for soldiers to practice maneuvering exercises, bivouacking, and using the small arms ranges.

2. It serves as a drinking water and wildlife protection area. The Reserve is the largest piece of undeveloped land on Cape Cod which serves as a drinking water source for Upper Cape Cod, and is home to 37 state-listed species living in a variety of habitats throughout the base.

The Reserve was created by the Massachusetts legislature through Chapter 47 of the Acts of 2002. This Act transferred the care, custody, and control of the Reserve (northern 15,000 acres of JBCC) from the Special Military Reservation Commission to the Division of Fisheries and Wildlife of the Massachusetts Department of Fish and Game. The Reserve is designated as public open space, subject to legal protection under both Article 97 of the Massachusetts Constitution and federal Section 4(f) of the DOT Act. Both laws recognize the high value this property provides to the community and requires substantial justification to develop these sites, including converting them to transportation uses.


***Exhibit 2-8 Upper Cape Water Reserve***

Chapter 47 of the Acts of 2002 also created an Environmental Management Commission (EMC) whose purpose is to ensure the permanent protection of the drinking water supply and wildlife habitat of the Reserve. The Reserve's enacting legislation requires that the Massachusetts National Guard comply with all environmental decisions and orders of the EMC. The EMC includes representatives from the Massachusetts Department of Fish and Game, the Department of Environmental Protection (MassDEP) and the Department of Conservation and Recreation. The Reserve is designated as public conservation land dedicated to three primary purposes:

1. Water supply and wildlife habitat protection,
2. The development and construction of public water supply systems, and,
3. The use and training of the military forces of the commonwealth; provided that such military use and training is compatible with the natural resource purposes of water supply and wildlife habitat protection.

The EMC oversees compliance with, and enforcement of, 19 Environmental Performance Standards. The Environmental

Performance Standards are specifically created through the Massachusetts Environmental Policy Act (MEPA) process to protect the resources in the Reserve. The 19 standards pertain to rare species and habitat management, hazardous materials, solid waste, and pest and fire management. The goal is to ensure the protection of the groundwater and habitat during conduct of compatible military training and civilian use activities, such as hunting.

### 2.1.4 Cultural, Historical, and Archaeological Resources

There are many important cultural resources in the study area (Exhibit 2-9). Bourne, Plymouth, Sandwich, and Wareham are rich in historic resources and open space properties. The key historic sites and districts in the study area include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich. Several public buildings in Bourne are individually listed on the National Register of Historic Places including Bourne High School, Jonathan Bourne Public Library, and Bourne Town Hall.

***Exhibit 2-9 Historic Districts and Individual Historic Properties***

Overall, cultural resources are categorized as historic, archaeological, and/or cultural/ethnographic:

- Historic resources include above-ground man-made resources such as buildings, structures, objects, districts, landscapes, and sites that meet the criteria for listing in the National Register of Historic Places.
- Archaeological resources are buried pre-colonial Native American and historic-period sites.
- Cultural/ethnographic resources are above and below-ground areas of cultural sensitivity and importance to the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head (Aquinnah).

The study area, including Bourne, Plymouth, Sandwich, and Wareham, is rich in above-ground historic resources (Table 2-2):

- The Bourne Bridge and the Sagamore Bridge have been identified by the Massachusetts Historical Commission (MHC) as eligible for individual listing in the National Register of Historic Places (NRHP).
- The Cape Cod Canal area may also qualify for listing on the NRHP. The identified area contains 18 structures that add to the district's historical integrity.
- The eastern end of the Canal, and the land just south of it in Sandwich, is in the Old King's Highway Regional Historic District, listed in the State Register of Historic Places.
- All inventoried historic structures and districts in Sandwich are listed in the State Register of Historic Places, with some potentially eligible as NRHP districts.
- North and south of the Cape Cod Canal, in Bourne, are many buildings and districts that are listed, eligible for listing, or potentially eligible for listing in the NRHP (Table 2-1).
- In Plymouth, the Indian Cemetery on the south shore of Great Herring Pond is potentially eligible for the NRHP as a contributing resource to the MHC-inventoried Cedarville District (PLY.G).

The focus area is also rich in archaeological and cultural resources. For thousands of years, the river, marsh, and coastal resources on Cape Cod made the area a prime location for Native American settlements. This is demonstrated through both archaeological finds made during the Canal's construction and oral tradition among the Wampanoag tribes. Archaeological surveys previously undertaken as part of cultural resource management projects in the focus area have identified dozens

*Table 2-1 Historic Status of Resources Inventoried by the Massachusetts Historic Commission*

| SR LISTED | NAME | NR (INDIVIDUAL PROPERTIES) | NR-ELIGIBLE PER MHC | POTENTIALLY NR-ELIGIBLE (DISTRICT) | POTENTIALLY NR-ELIGIBLE PROPERTIES | SR-LISTED |
|---|---|---|---|---|---|---|
| **CAPE COD CANAL** | | | | | | |
| BOU.918 | Bourne Bridge | | ✱ | | | |
| BOU.919 | Sagamore Bridge | | ✱ | | | |
| BOU.AF | Cape Cod Canal | | | ✱ | | |
| SDW.Z | Cape Cod Canal | | | ✱ | | ✱ |
| **NORTH OF CANAL** | | | | | | |
| BOU.388 | Mass. Army NG Armory | | ✱ | | | |
| BOU.C | Head of the Bay | | | | 1 | |
| BOU.I | Bournedale | 1 | | | 3 | |
| BOU.J | Main Street Commercial Area | | | | 2 | |
| BOU.O | North Sagamore | | | | 3 | |
| BOU.P | Savery Avenue | | | | | |
| BOU.U | Sagamore Beach | | | | 3 | |
| BOU.AE | Bourne Town Hall | 1 | | | | ✱ |
| PLY.G | Cedarville | | | ✱ | | |
| SDW.AA | Sagamore Hill Gun Battery | | | ✱ | | ✱ |
| **SOUTH OF CANAL** | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | ✱ | 6 | |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | |
| BOU.AG | Aptucxet Trading Post | | | ✱ | | |
| BOU.AH | Shore Road North | | | | 1 | |
| BOU.AJ | County Road North | | | | | |
| BOU.V | South Sagamore | | | ✱ | 8 | |
| SDW.906 | Route 6 Bridge | | | | | ✱ |
| SDW.907 | Route 6 Bridge | | | | | ✱ |
| SDW.F | Shawme Road | | | ✱ | | ✱ |
| SDW.G | Route 6A West | | | | | ✱ |
| SDW.I | Main Street | | | | | ✱ |
| SDW.R | Old Kings Highway Regional HD | | | | | ✱ |

*MHC = Massachusetts Historical Commission; NR = National Register of Historic Places; SR = State Register of Historic Places*

of archaeological sites. Areas of cultural importance to the Wampanoag tribes are present in numerous locations in the focus area.

Due to sensitivity of the location of archaeological sites and other areas culturally important to Tribal culture, this study does not identify their locations. Both the National Historic Preservation Act and the Archaeological Resources Protection Act mandate that Federal agencies only disclose archaeological site locations if no harm, theft, or destruction of cultural resources will result from disclosure.

In addition to these sites, historic-period Euro-American sites are also likely present in the study area given colonial settlement on the Cape in the early 17th century.

*Appendix C, the Cape Cod Transportation Study—Cultural Resources Identification and Evaluation*, includes a detailed description of the cultural resources in the study area.

### 2.1.5 Protected Open Space

Numerous properties in the study area are designated as protected open space (Exhibit 2-10). Examples of these publicly- and privately-owned properties include the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Bourne Scenic Park, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

These open space properties serve a wide variety of purposes, including watershed protection, wildlife habitat, conservation, and recreation. Their owners include the federal government (U.S. Army Corps of Engineers), the Commonwealth of Massachusetts (Division of Fisheries & Wildlife, the Department of Conservation and Recreation), Barnstable County, municipalities, water districts, and private conservation or wildlife trusts.

***Exhibit 2-10 Protected Open Space***

While varying levels of legal protection safeguard these resources, the publicly-owned properties receive protection under both Article 97 of the Massachusetts Constitution and Section 4(f) of the DOT Act. Both laws recognize the high value these properties provide to the community and require substantial justification to convert them to other uses, including transportation uses.

### 2.1.6 Utilities

Important utility corridors cross the study area. These include an electrical utility corridor which transmits electricity through transmission towers from the Canal Generating Plant in Sandwich northwest across the Canal and east to Cape Cod customers (Exhibit 2-11). Natural gas enters Cape Cod within a pipe network that crosses the Canal attached to the Canal bridges. Natural gas compressor stations are located close to both the Sagamore and Bourne Bridges.

These electrical transmission towers and gas lines and compressor stations represent a substantial constraint when considering future work on the Canal bridges.

***Exhibit 2-11 Utilities***


**Exhibit 2-12** **Environmental Justice Populations**

### 2.1.7 Environmental Justice Populations

Environmental Justice (EJ) refers to an effort to ensure the fair distribution of environmental benefits and burdens created by any action of the federal government. President Clinton issued Executive Order 12898—Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations in 1994. It directs all federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law.

At the state level, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) ensures that state agencies, divisions, and other entities (including MassDOT) identify and address EJ populations in their projects or other actions. The EEA's Environmental Justice Policy was updated in 2017.

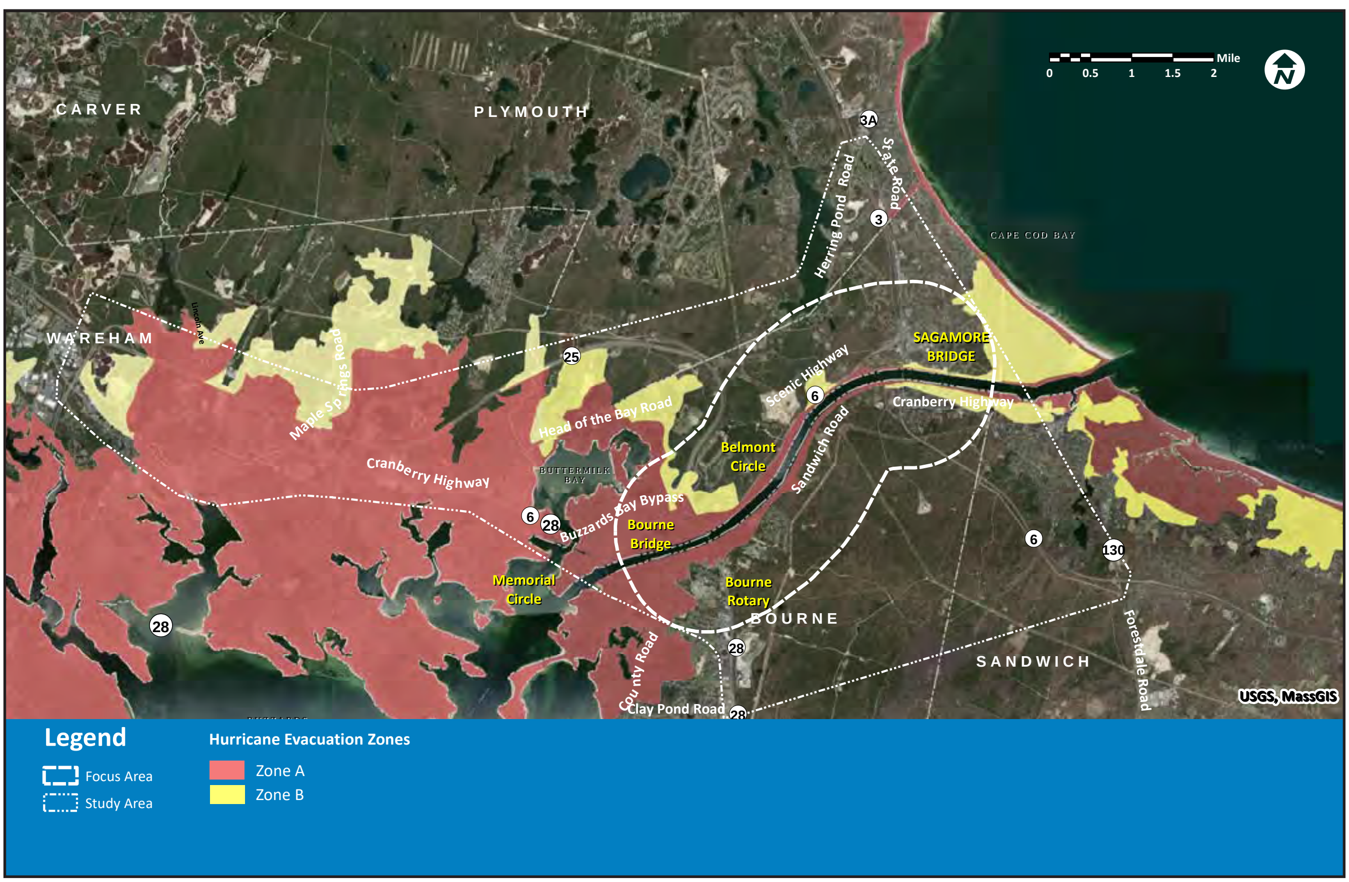
EJ populations are identified according to three criteria: minority (non-white) status, income, and English isolation, which is a metric of English language fluency. Minority status is determined at the block group level with U.S. Census data, and English isolation and income are determined at the state level

with American Community Survey (ACS) data. The thresholds that determine EJ status are:

- 25% of households within the census block have a median household income at or below the statewide median income for Massachusetts (2016: $75,297); or
- 25% or more of residents are minority (defined as those who identify themselves as Latino/Hispanic, Black/African American, Asian, Indigenous people, and people who otherwise identify as non-white); or
- 25% or more have English isolation (defined as those that do not have an adult over 14 years old that speaks only English or English very well).

According to the data from the 2010 US Census, the only environmental justice populations in the study area are in Wareham (Exhibit 2-12). The Village of Onset in Wareham and areas west of Onset contain high minority populations (higher than the state average). Other areas in Wareham, including areas surrounding Main Street and west of the I-495/I-195 Interchange, contain areas of low-income populations.

***Exhibit 2-13 MEMA Hurricane Evacuation Zones***



The study team also reviewed the recommendations within the National Cooperative Highway Research Program Report No. 532 (NCHRP 532), titled Effective Methods for Environmental Justice Assessment. This report emphasized that beyond considering low-income and minority populations, it is appropriate to consider other demographic characteristics such as race, national origin, age, disability, and English-speaking ability.

### 2.1.8 MEMA Evacuation Zones

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating the planning and response of federal, state, local, voluntary, and private resources during emergencies or disasters, including hurricanes, flooding events, winter storms, nuclear or terrorist events or other natural and man-made disasters.

MEMA has established statewide evacuation zone maps in Massachusetts. On Cape Cod, the evacuation of residents, workers, and visitors may be necessary during a hurricane or tropical storm due to risk of storm surge. A storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tide. The destructive power of a storm surge and large battering waves is often the greatest threat to life and property during a storm, and can result in loss of life, destroyed buildings, beach and dune erosion, and road and bridge damage along the coast.

Evacuation zones A and B exist within the study area (Exhibit 2-13). These zones include areas that, depending on predicted inundation, may flood first from storm surge during a tropical storm or hurricane. Areas in Zone A would flood before areas in Zone B.

The reliability of multimodal travel across the Canal would be critical during an evacuation, this includes ensuring the accessibility of the Canal bridges and all roadway approaches to the bridges.

## 2.2 LAND USE AND DEVELOPMENT

This section includes a discussion of existing land uses within the study area.

### 2.2.1 Land Uses within the Study Area

The study area is characterized by a wide variety of land uses (Exhibit 2-14). Along Route 25, land uses include forested areas, interspersed with cranberry bogs, and residential development (particularly on the south side of Route 25). Land use shifts to

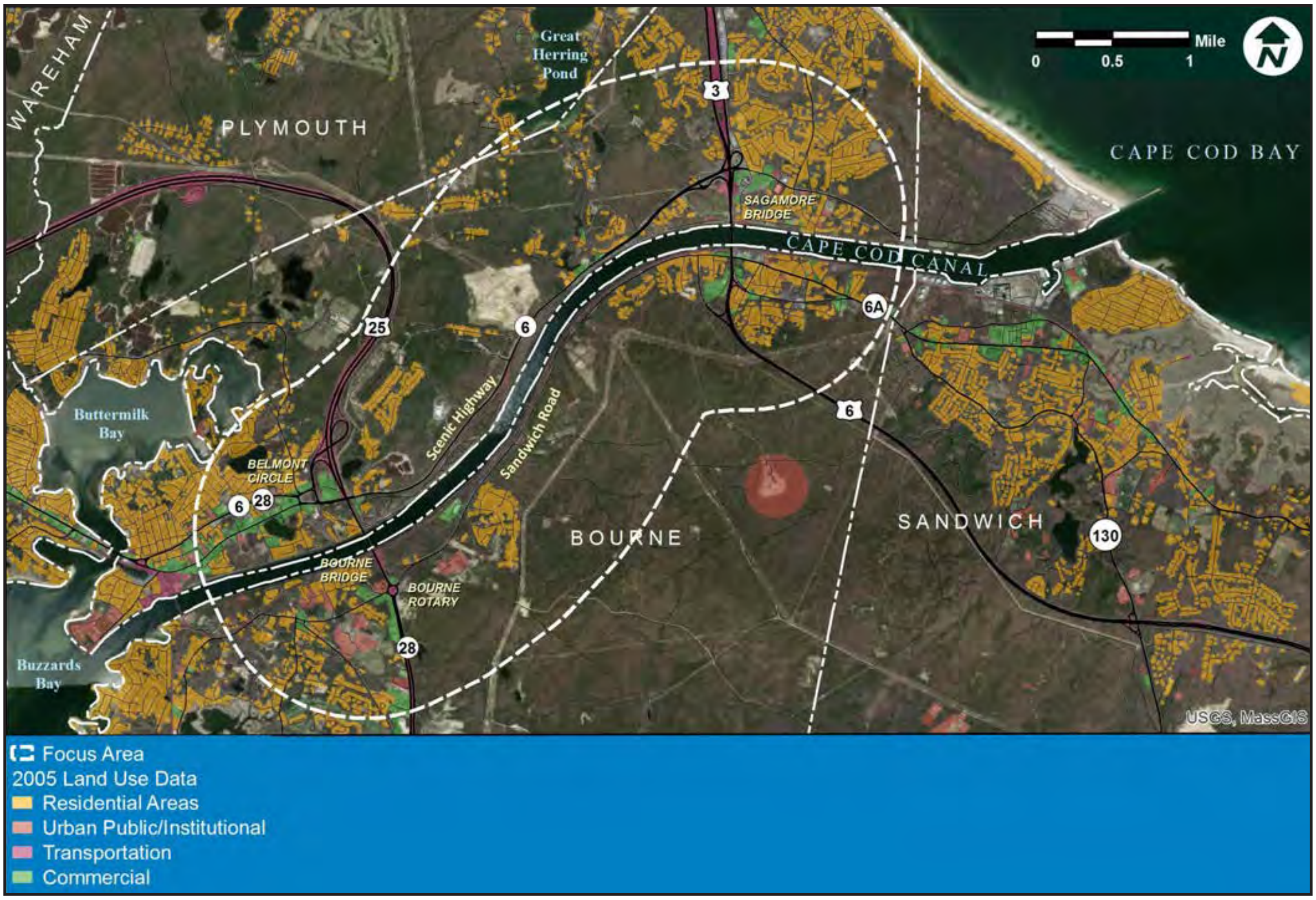



***Exhibit 2-14 Land Uses in the Study Area***

more high-density residential and commercial development in the Buzzard's Bay section of Bourne.

Located west of Route 28 (south of the Bourne Bridge) are medium- to low-density residential developments and commercial properties. The Bourne Back River ACEC, described in Section 2.1.5, is west of Route 28 and Waterhouse Road. East of Route 28, from Bourne to Route 6 in Sandwich, land use is predominantly protected open space, identified as the Upper Cape Water Supply Reserve (described in Section 2.1.7).

East and west of Route 3, in the northeast portion of the study area, land uses include medium-density residential development with dispersed pockets of municipally-owned open space. Great Herring Pond, a 376-acre pond in Plymouth, is the largest of multiple ponds found west of Route 3. To the east, from Route 3 to the Sagamore Beach in Sandwich, the landscape is characterized by medium-density single- and multi-family residential developments. Further east (and north of the Canal), land use transitions to open space including the Scusset Beach State Reservation (owned by the U.S. Army Corps of Engineers) and a large expanse of wetland marshes.

East of Route 6, south of the Canal, land uses in Bourne and Sandwich include the 624 acre Shawme-Crowell State Forest. The Massachusetts Department of Conservation and Recreation (DCR) owns and manages this state forest, which is protected open space. East of the state forest, development between Route 130 and Route 6A in Sandwich consists of high- to low-density residential uses.

Along Route 6A, land use in Sandwich includes high-density residential development and commercial properties, particularly west of this corridor. Further east of Route 6A in Sandwich, land use is characterized by concentrations of dense residential development with extensive areas of municipally managed wetland resource areas.

### 2.2.2 Joint Base Cape Cod

Joint Base Cape Cod (JBCC) is a nearly 21,000-acre full scale, joint-use base home to five military commands training for missions at home and overseas, conducting airborne search and rescue missions, and intelligence command and control. Numerous important military training and operating facilities exist at JBCC including:

**Tactical Training Base (TTB) Kelley** replicates a forward operating base soldiers occupy when deployed overseas.

**102nd Intelligence Wing** provides world-wide precision intelligence and command and control along with trained and experienced Airmen for expeditionary combat support and homeland security.

**U.S. Coast Guard Base Cape Cod** serves as the single Deputy Commandant for Mission Support (DCMS) touch point for the support of Coast Guard operations within the 1st Coast Guard District.

**Air Station Cape Cod (ASCC)**, with its three helicopters and four jets, is the only Coast Guard Aviation facility in the northeast. ASCC is responsible for the waters from New Jersey to the Canadian border and maintains the ability to launch a helicopter and/or jet within 30 minutes of a call, 365 days-a-year, 24 hours-a-day, and in nearly any weather condition.

**Camp Edwards** is the primary military training facility for the National Guard and Army Reserve for soldiers throughout New England. The primary mission of Camp Edwards is to prepare soldiers for combat missions overseas as well as missions to serve and protect the United States.

**Upper Cape Water Supply Reserve** The 15,000 acres of the northern portion of JBCC is designated as the Upper Cape Water Supply Reserve which, as described in Section 2.1.7 is the largest piece of protected, undeveloped land on Cape Cod providing drinking water and wildlife protection and is used jointly for training by the Massachusetts Army and Air National Guard and the U.S. Coast Guard.

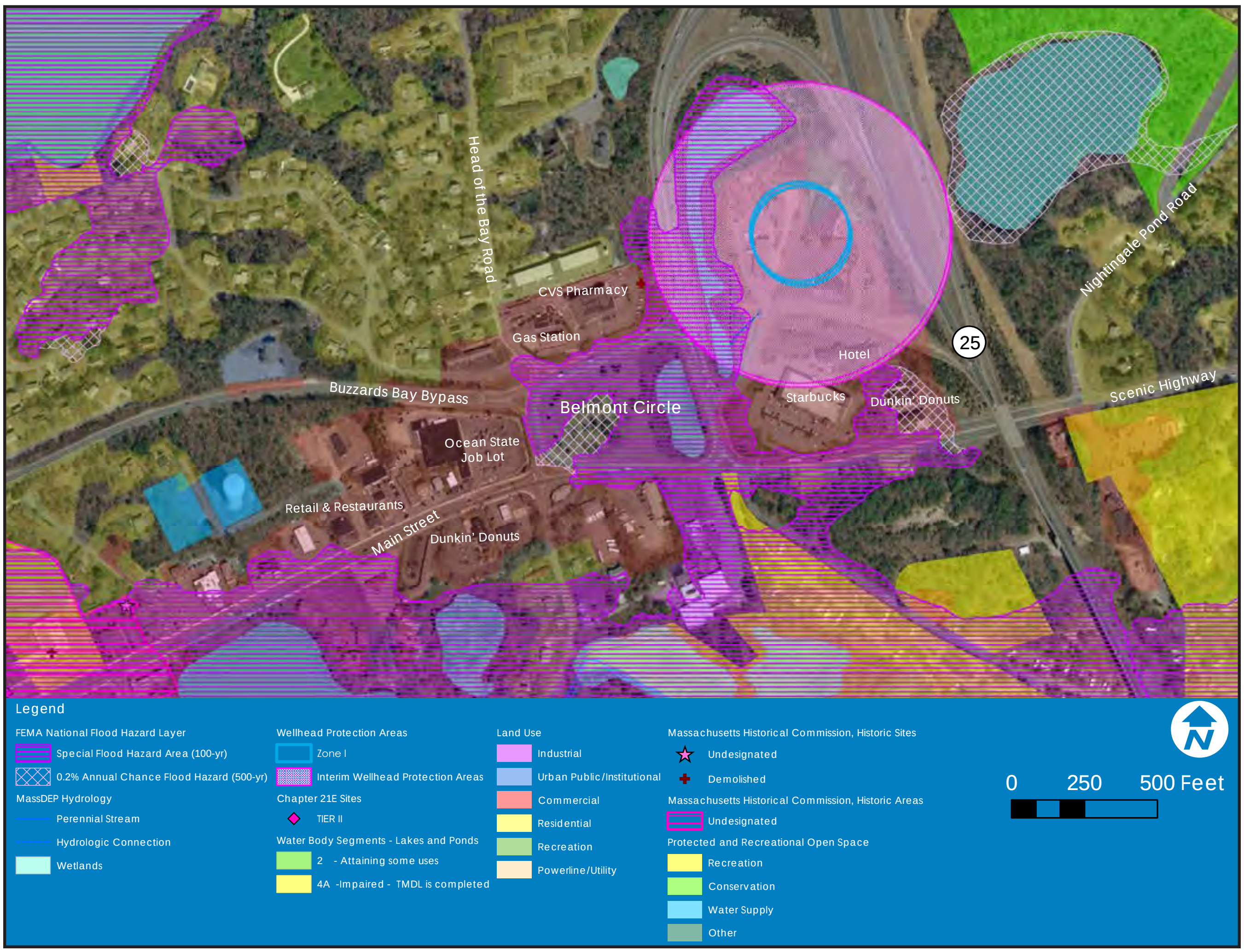
### 2.2.3 Belmont Circle and Bourne Rotary

As Belmont Circle and the Bourne Rotary are two of the most critical intersections in the study area, this section provides information on the existing land uses and environmental resource found at these locations. The existing traffic conditions at these locations are provided in Section 2.5.10.

#### *Belmont Circle*

This section describes the existing land uses and environmental resources at Belmont Circle and the adjacent Scenic Highway at Nightingale Pond Road intersection.

***Exhibit 2-15 Existing Land Uses and Environmental Resources - Belmont Circle***



*Land Uses and Environmental Resources*

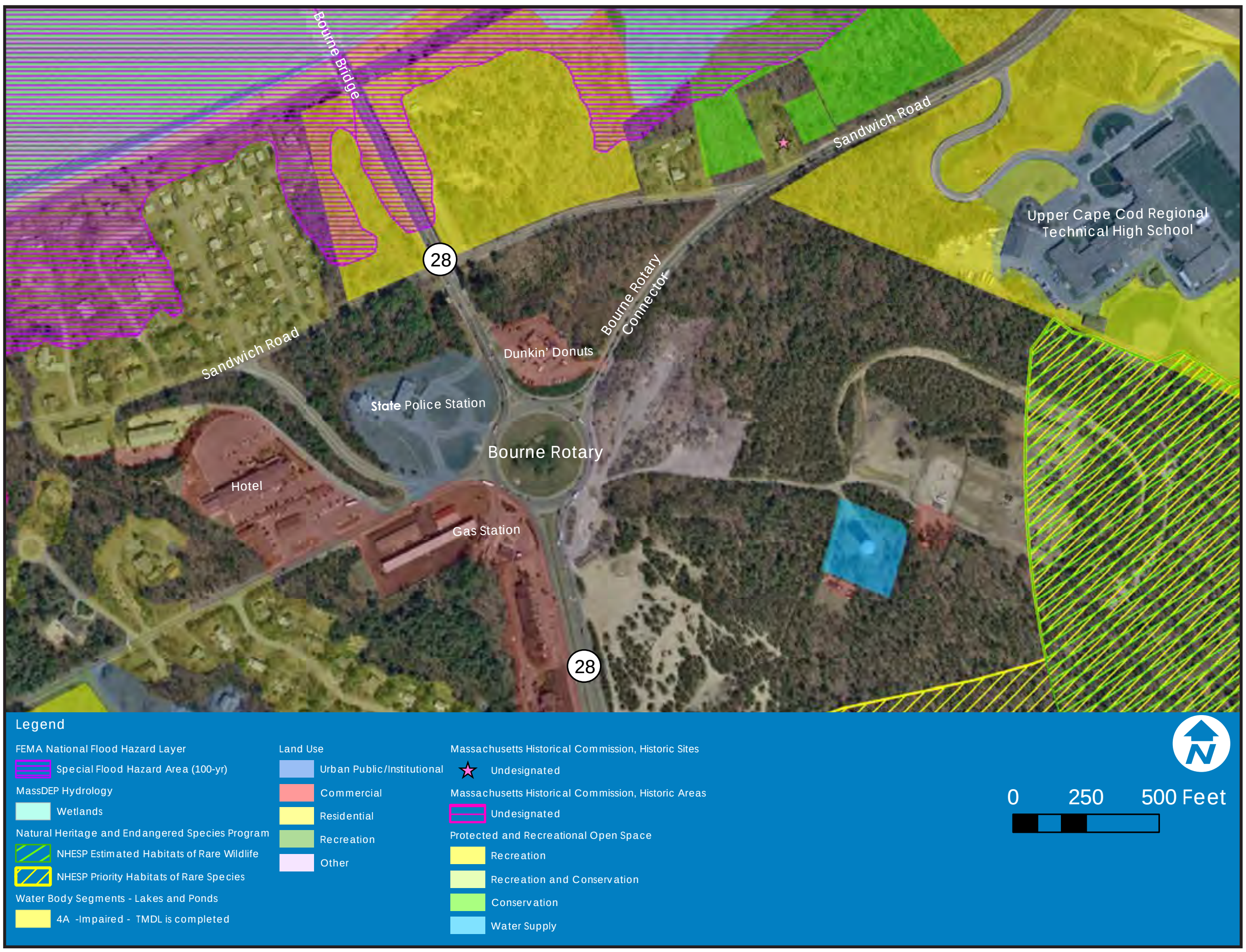
Land uses adjacent to Belmont Circle include numerous retail and restaurant business, such as CVS pharmacy, Starbucks, Mobil Gas, and Ocean State Job Lot, have direct access to Belmont Circle. West of Belmont Circle, Main Street includes numerous retail and restaurant establishments in Bourne's business district and Bourne town hall and police station.

Natural resources in the Belmont Circle area include a one-acre wetland on the east side of the Circle infield. The 100-year floodplain extends from the Canal north to Main Street and the entire Belmont Circle area (see Exhibit 2-15).

## Bourne Rotary

This section describes the existing land uses and environmental resources in the Bourne Rotary area.

**Exhibit 2-16 Existing Land Uses and Environmental Resources - Bourne Rotary**



*Land Uses and Environmental Resources*

Land uses adjacent to the Bourne Rotary include Dunkin' Donuts and a Cumberland Farms Convenience store and gas station. A Massachusetts State Police barracks is adjacent to the northwest side of the Rotary.

Several schools are in the Bourne Rotary area. The entrance to the Upper Cape Cod Regional Technical High School is 0.4 miles to the east of the Rotary on Sandwich Road. The entrance to the Bourne Middle and High School and the James Pebbles Elementary School are 0.4 miles west of the Rotary on Trowbridge Road.

Traveling east on Sandwich Road from the Rotary for ¼-mile leads to the entrance of the Upper Cape Cod Regional Technical High School. Several restaurants and retail businesses, including Dunkin Donuts and Gulf Oil have direct access to the rotary. Undeveloped land exists east and south of the rotary. No wetland or floodplain areas exist in the Bourne Rotary area (see Exhibit 2-16).

## 2.3 SOCIO-ECONOMIC CONDITIONS

The socio-economic conditions in Barnstable, Dukes (Martha's Vineyard and nearby islands), and Nantucket counties were evaluated using data from sources including the U.S. Census, the U.S. Department of Labor, the Massachusetts Department of Revenue, and the Nielsen Company. Because the study area includes portions of Wareham and Plymouth, this report also includes certain socioeconomic data for these towns.

This evaluation documents existing conditions and recent trends for population, household makeup, income, employment, and journey to work data.

### 2.3.1 Population

Socio-economic conditions in Barnstable County (Cape Cod) are in transition. After several decades of rapid population and employment growth, the county has experienced a population decline since 2000. The demographics of this population is also shifting to a higher percentage of senior citizens and a lower percentage of working adults and school-age children.

*Table 2-2 Historical Population Change in Barnstable County*

| | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| Population | 70,286 | 96,656 | 147,925 | 186,605 | 222,230 | 215,888 | 213,444 | 213,413 |
| % Change from previous period | | 37.52 | 53.04 | 26.15 | 19.09 | -2.85 | -1.13 | -0.01 |

*Source: US Census Bureau*

The population of Barnstable County grew rapidly between 1960 and 2000. Table 2-2 shows growth from approximately 70,000 to more than 220,000 residents during this 40-year period, a 214% increase. However, this growth faltered in the period 2000-2010, with the county experiencing a population decline of 2.85%. The population lost an additional 1.13% from 2010 to 2017. Forecasts for Barnstable County[1] project modest population growth of 2.53% between 2010 and 2019.

By comparison, the population of Plymouth County grew 4.9% between 2000 and 2010 and an additional 3.9% between 2010 and 2017. The population of Plymouth County is forecast to grow an additional 1.7% between 2017 and 2019. The population of Massachusetts as a whole grew 3.1% in the ten years from 2000 to 2010 and an additional 4.5% between 2010 and 2016.

Nantucket and Dukes counties have also experienced significant increases in population since1960. Between 1960 and 2016, Nantucket County's population increased approximately 209% from 3,559 to 11,008 persons. In the same period, Dukes County's population rose approximately 196%, from 5,829 to 17,246 persons. Neither experienced a more recent decline like the one in Barnstable County.

*Table 2-3 Change in Age Cohorts 2000–2017, Barnstable County*

| | 2000 | 2017 | % CHANGE |
|---|---|---|---|
| Total population | 222,230 | 213444 | -3.95 |
| Under 5 years | 10,599 | 7,764 | -26.8 |
| 5 to 9 years | 12,811 | 8,670 | -32.3 |
| 10 to 14 years | 14,208 | 9,579 | -32.6 |
| 15 to 19 years | 11,725 | 10,375 | -11.51 |
| 20 to 24 years | 7,735 | 11,002 | 42.2 |
| 25 to 34 years | 21,595 | 18,962 | -12.2 |
| 35 to 44 years | 33,982 | 18,558 | -45.4 |
| 45 to 54 years | 32,802 | 27,220 | -17.0 |
| 55 to 64 years | 25,508 | 37,546 | 47.2 |
| 65 to 74 years | 26,357 | 36,218 | 37.4 |
| 75 to 84 years | 11,075 | 18,794 | 69.7 |
| 85 years and over | 6,447 | 8756 | 35.8 |

*Source: US Census Bureau, American Community Survey, 2017*

Barnstable County has also experienced changes in the age groups (or cohorts) that make up its population (Table 2-3). Between 2000 and 2017, the population of Barnstable County remained relatively stable (decreasing by 3.95%) however, the county experienced considerable change in age cohorts.

1 The Nielsen Company, Site Reports, 2014 data.

Specifically, the population of pre-school and school-age children (residents ages 1 19) dropped significantly, as did the number of working-age adults aged 25 to 54. Conversely, the county experienced a considerable increase in older residents (residents older than 55).

While the drop in the number of prime working-age adults (and their children) is partially due to the natural aging of the large baby boomer generation, the extent of these changes is also likely due, in part, to the increasing cost of Cape Cod residential real estate and limited growth opportunities for local employment. At the same time, 19% of persons who own second homes on Cape Cod have reported their intention to convert these homes to their primary residences over the next 20 years[2]. This would result in the conversion of approximately 11,000 second homes on Cape Cod to primary residences. While this trend may increase the year-round population of Cape Cod, without changes to local zoning or housing stock, it would decrease the stock of rental homes available for visitors.

Any discussion of Barnstable County's population must acknowledge its seasonality. During the summer tourist season, the population of the county nearly doubles, increasing by approximately 200,000 people due to the influx of seasonal residents, employees, and visitors[3]. This substantial increase in the summertime population (with related increases in vehicle trips) places tremendous pressure on the transportation system in the Cape Cod Canal area.

### 2.3.2 Housing Units

A housing unit is defined as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

*Table 2-4 Housing Units (2005–2015), Barnstable, Dukes, and Nantucket Counties and the Commonwealth of Massachusetts*

| COUNTY/COMMONWEALTH | 2005 | 2010 | 2015 | % INCREASE, 2000–2015 |
|---|---|---|---|---|
| Barnstable | 153,798 | 160,281 | 162,118 | 4.22 |
| Dukes | 15,896 | 17,188 | 17,614 | 8.13 |
| Nantucket | 10,296 | 11,618 | 11,951 | 12.84 |
| Massachusetts | 2,688,014 | 2,808,254 | 2,845,699 | 4.46 |

*Source: US Census Bureau, American Community Survey*

2 UMass Donahue Institute, Cape Cod Second Homeowners, Technical Report of 2017 Survey Findings, Cape Cod Commission, June 2017.
3 Cape Cod Commission, 2015. Calculations based on the UMass Donahue Institute Second Home Owner Survey 2008 and 2010 U.S. Census.

According to U.S. Census Bureau, the number of housing units in Barnstable County increased slightly between 2005 and 2010 and again between 2010 and 2015 (Table 2-4). In the five years ending in 2010, the county experienced a 4.2% increase in housing units; from 2010 to 2015, the increase was only 1%. Dukes and Nantucket counties experienced stronger growth in housing units from 2000 to 2015 (8.13% and 12.84%, respectively). In comparison, the Commonwealth of Massachusetts experienced a more modest 4.5% increase in housing unit growth between 2005 and 2015. Overall, the rate of housing construction in Barnstable County between 2005 and 2015 has kept pace with the construction rate in Massachusetts as a whole, although it slowed considerably from 2010 to 2015.

As a major summer tourist destination, Barnstable County has traditionally had a large percentage of housing units serving as seasonal housing, i.e. second homes. Currently, approximately 38% (62,000 of the 162,000) of the housing units in Barnstable County are seasonal units[4]. The percentage of housing units serving as seasonal units has been increasing since the 2007-2009 recession and is forecast to continue to increase in the future.

### 2.3.3 Median Household Income

The U.S. Census Bureau defines a household as all the people who occupy a housing unit as their usual place of residence. The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements. "Median household income" refers to the income earned by a given household where half of the households in an area earn more and half earn less.

According to the American Community Survey (ACS), the median household income for Barnstable County in 2017 was $68,048,

*Table 2-5 Median Household Income, 2017*

| | BARNSTABLE COUNTY | DUKES COUNTY | NANTUCKET COUNTY | MASSACHUSETTS |
|---|---|---|---|---|
| Median Household Income | $68,048 | $67,535 | $91,942 | $74,167 |

*Source: American Community Survey, 2017*

*Table 2-6 Per Capita Income, 2017*

| | BARNSTABLE COUNTY | DUKES COUNTY | NANTUCKET COUNTY | MASSACHUSETTS |
|---|---|---|---|---|
| Per Capita Income | $40,886 | $42,956 | $47,924 | $39,913 |

*Source: U.S. Census Bureau American Community Survey, 2017 (http://www.census.gov/quickfacts/table/PST045215/25,25007,25001,25019)*

4 Regional Housing Market Analysis and 10-year Forecast of Housing Supply and Demand for Barnstable County, Massachusetts, September, 2017, Cape Cod Commission.

roughly 8% less than the statewide median of $74,167 (Table 2-5). The median household income for Barnstable County was also 26% less than the Nantucket County and 0.7% more than Dukes County. Overall, the median household income in Barnstable County is below the state median income but approximately the same as most Massachusetts counties other than Middlesex and Norfolk County.

Table 2-6 compares per capita incomes for Barnstable, Dukes, and Nantucket counties and the Commonwealth of Massachusetts. "Per capita income" is the average income for every person in a particular household group, including those living in group quarters. It is derived by dividing the aggregate income of a particular group by the total population in that group.

According to 2017 American Community Survey data, per capita incomes for Barnstable County were slightly higher (2.4%) than that of Massachusetts as a whole. The per capita income for Nantucket County was approximately 14.6% higher than Barnstable County. Based on a comparison of median household income (Table 2-5) and per capital income (Table 2-6), a greater percentage of households statewide have multiple employed residents, resulting in a higher total household income.

### 2.3.4 Employment

Historically, Cape Cod and the Islands (Barnstable, Dukes, and Nantucket counties) have experienced considerable seasonal variation in employment, related to their long standing economic dependence on tourism and seasonal service industries.

*Table 2-7 Monthly 2017 Labor Force and Unemployment Data, Barnstable County*

| MONTH | LABOR FORCE | EMPLOYED | UNEMPLOYED | MONTHLY UNEMPLOYMENT RATE[1] | |
|---|---|---|---|---|---|
| | | | | BARNSTABLE COUNTY | MASSACHUSETTS[2] |
| January | 105,866 | 97,764 | 8,102 | 7.7% | 4.5% |
| February | 105,480 | 97,515 | 7,965 | 7.6% | 4.4% |
| March | 106,188 | 99,071 | 7,117 | 6.7% | 4.1% |
| April | 107,514 | 102,239 | 5,275 | 4.9% | 3.6% |
| May | 110,992 | 106,293 | 4,699 | 4.2% | 3.7% |
| June | 120,469 | 115,937 | 4,532 | 3.8% | 4.0% |
| July | 126,272 | 121,981 | 4,291 | 3.4% | 4.0% |
| August | 125,602 | 121,616 | 3,986 | 3.2% | 3.6% |
| September | 114,309 | 110,471 | 3,838 | 3.4% | 3.5% |
| October | 111,049 | 107,483 | 3,566 | 3.2% | 3.1% |
| November | 108,557 | 104,167 | 4,390 | 4.0% | 3.0% |
| December | 107,563 | 102,507 | 5,056 | 4.7% | 3.1% |
| Annual | 112,489 | 107,254 | 5,235 | 4.7% | 3.7% |

[1] U.S. Bureau of Labor Statistics Unemployment rates by county and state, not seasonally adjusted, Massachusetts, 2017

[2] Massachusetts Department of Unemployment Assistance; U.S. Bureau of Labor Statistics, not seasonally adjusted, 2017 (http://lmi2.detma.org/lmi/lmi_lur_b.asp?A=04&GA=000001&T-F=3&Y=2017&Sopt=&Dopt=TEXT)

Tables 2-7 and 2-8 demonstrate this trend in 2017 by charting unemployment rates in January (historically when unemployment on the Cape and Islands peaks) through August (historically when unemployment rates are lowest). Data for September through December and the annualized data for 2017 are also provided.

U.S. Bureau of Labor Statistics data for 2017 shows that, at 7.7%, Barnstable County's January unemployment rate was more than double its 3.2% August rate. The data also demonstrate that Barnstable County experienced higher rates of unemployment compared to the state from January to May, which coincides with Cape Cod's tourist off-season.

*Table 2-8 Labor Force and Unemployment Data by Municipality, August 2017 Cape Cod and the Islands*

| CITY/TOWN | LABOR FORCE | EMPLOYED | UNEMPLOYED | UNEMPLOYMENT RATE |
|---|---|---|---|---|
| **BARNSTABLE COUNTY** | | | | |
| Barnstable | 26,726 | 26,726 | 909 | 3.4% |
| Bourne | 11,927 | 11,466 | 461 | 3.9% |
| Brewster | 5,797 | 5,651 | 146 | 2.5% |
| Chatham | 3,292 | 3,210 | 82 | 2.5% |
| Dennis | 7,386 | 7,148 | 238 | 3.2% |
| Eastham | 2,864 | 2,798 | 66 | 2.3% |
| Falmouth | 17,328 | 16,746 | 582 | 3.4% |
| Harwich | 6,791 | 6,595 | 196 | 2.9% |
| Mashpee | 8,824 | 8,540 | 284 | 3.2% |
| Orleans | 3,207 | 3,137 | 70 | 2.2% |
| Provincetown | 2,162 | 2,106 | 56 | 2.6% |
| Sandwich | 12,754 | 12,375 | 379 | 3.0% |
| Truro | 1,333 | 1,303 | 30 | 2.3% |
| Wellfleet | 1,811 | 1,771 | 40 | 2.2% |
| Yarmouth | 13,400 | 12,953 | 447 | 3.3% |
| **DUKES COUNTY** | | | | |
| Aquinnah | 275 | 272 | 3 | 1.1% |
| Chilmark | 632 | 619 | 13 | 2.1% |
| Edgartown | 3,076 | 3,003 | 73 | 2.4% |
| Gosnold | 53 | 52 | 1 | 1.9% |
| Oaks Bluffs | 3,335 | 3,256 | 79 | 2.4% |
| Tisbury | 2,917 | 2,830 | 87 | 3.0% |
| West Tisbury | 2,070 | 2,023 | 47 | 2.3% |
| **NANTUCKET COUNTY** | | | | |
| Nantucket | 9,532 | 9,369 | 163 | 1.7% |
| **Cape & Islands (total)** | **147,492** | **143,040** | **4,452** | **3.0%** |
| **PLYMOUTH COUNTY** (SELECT MUNICIPALITIES) | | | | |
| Plymouth | 31,612 | 30,472 | 1,140 | 3.6% |
| Wareham | 14,175 | 13,608 | 567 | 4.0% |

*Source: MA DUA, US DOL, Local Area Unemployment Statistics (LAUS), not adjusted for seasonality. Tables drawn from http://lmi2.detma.org/lmi/lmi_lur_a.asp.*

Conversely, during the peak tourist season, from June to September, Barnstable County experienced lower unemployment rates than Massachusetts as a whole. The 2017 labor force data show that the size of the labor force in the county grows and shrinks in response to seasonal demand, from a July peak of 126,272 persons to a February low of 105,480 persons, a 20% difference. Dukes and Nantucket counties experience even larger percentage increases from peak summer rates to their winter low.

Table 2-8 presents labor force and unemployment data by municipality for the Cape and Islands during August 2017. August is historically the month when unemployment rates in the region are the lowest. As the study area encompasses parts of Wareham and Plymouth, labor force and unemployment data are also provided for these towns.

The highest rates of unemployment in August 2017 were reported in the towns of Wareham (4.0%), Bourne (3.9%), and Plymouth (3.6%), each of which was equal or higher than the statewide rate of 3.6%. Unemployment for all the other towns on Cape Cod and the Islands was lower than the statewide rate. Improving transportation mobility on- and off-Cape Cod may increase year-round employment on Cape Cod, reducing the seasonal variability in the unemployment rates.

### 2.3.5 Journey to Work

This section describes the different methods that commuters in Barnstable County use for getting to work. According to 2010 and 2017 American Community Survey 5-Year Estimates, the largest share of workers in Barnstable County (81.1%) drove alone to work in 2017, a decrease of 0.6% since 2010. The second most common means of traveling to work was by carpool. Taken together, nearly 90% of commuters use private automobiles to

*Table 2-9 Mode of Commuter Transportation to Work in Barnstable County (2010-2017)*

| MODE OF TRANSPORTATION TO WORK | 2010 | 2017 |
|---|---|---|
| Drove Alone | 81.7% | 81.1% |
| Carpool | 7.1% | 7.2% |
| Work at Home | 5.6% | 6.3% |
| Walk | 2.9% | 2.5% |
| Public Transit (excluding taxi cab) | 1.2% | 1.3% |
| Other (includes bicycle travel) | 1.4% | 1.6% |

*Source: US Census Bureau, 2006-2010 and 2013-2017 American Community Survey 5-year estimates Dataset: ACS 5-year Estimates, 2006-2010 (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_S0801&prodType=table) and 2013-2017 (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_S0801&prodType=table)*

travel to work, accounting for the most important component of commuter transportation in Barnstable County (Table 2-9).

Crossing the two roadway bridges over the Canal represents an important part of the daily commute for many residents in Barnstable and nearby counties. U.S. Census data from 2010, shown in Table 2-10, indicate that 13,277 of Barnstable County residents (approximately 12% of working residents) crossed the Canal bridges to off-Cape workplaces. These data also show that residents from all 15 Barnstable County towns commuted off-Cape to work, ranging from 3,133 commuters from Bourne to 20 off-Cape commuters from Truro. Not surprisingly, the closer one lives to mainland Massachusetts the more likely one is to work off-Cape. A little less than one-third (32.4%) of all working Bourne residents commute to jobs off Cape (the highest percentage of any town on the Cape), followed by 19.6% of Sandwich workers, 13% of Falmouth workers and 12.9% of Mashpee workers. Note that portions of both Bourne and Sandwich are north of the Cape Cod Canal. Dennis, Eastham, Barnstable follow with 9.1%, 9.1% and 8.8% of resident workers commuting off-Cape, respectively. Outer-Cape towns such as Provincetown, Truro, and Wellfleet had the lowest percentages of commuters who travel to jobs off-Cape. Table 2-10 illustrates the distribution of off-Cape commuting from Barnstable County by town.

*Table 2-10 Barnstable County Labor Force Commuting Off-Cape to Work (2010)*

| | | PLACE OF WORK | | |
|---|---|---|---|---|
| TOWN OF RESIDENCE | ALL WORKERS | ON-CAPE | OFF-CAPE | PERCENT WORKING OFF-CAPE |
| Barnstable | 24,034 | 21,922 | 2,112 | 8.8% |
| Bourne | 9,675 | 6,542 | 3,133 | 32.4% |
| Brewster | 5,112 | 4,833 | 279 | 5.5% |
| Chatham | 3,120 | 2,873 | 247 | 7.9% |
| Dennis | 7,328 | 6,663 | 665 | 9.1% |
| Eastham | 2,524 | 2,294 | 230 | 9.1% |
| Falmouth | 16,595 | 14,443 | 2,152 | 13% |
| Harwich | 5,743 | 5,488 | 255 | 4.4% |
| Mashpee | 7,382 | 6,432 | 950 | 12.9% |
| Orleans | 2,772 | 2,597 | 175 | 6.3% |
| Provincetown | 1,745 | 1,665 | 80 | 4.6% |
| Sandwich | 10,594 | 8,520 | 2,074 | 19.6% |
| Truro | 1,312 | 1,292 | 20 | 1.5% |
| Wellfleet | 1,460 | 1,405 | 55 | 3.8% |
| Yarmouth | 10,896 | 10,046 | 850 | 7.8% |
| **Barnstable County (Total)** | **110,292** | **97,015** | **13,277** | **12%** |

*Source: US Census Bureau, 2010*

Similarly, a substantial number of workers (9,030) travel from mainland Massachusetts to workplaces on Cape Cod. Overall, 22,307 commuters cross one of the Canal bridges twice a day during their work commute.

## 2.4 PUBLIC HEALTH CONDITIONS

The prevalence of health problems in Barnstable County was determined using data from the Massachusetts Department of Public Health (DPH).

The leading causes of death in Barnstable County mirror those statewide and include heart disease (25.1%), cancer (24.6%), and stroke (5.9%). Health problems include asthma, heart disease, diabetes, and depression. The data highlight factors that increase the risk of health-related problems, such as obesity and smoking. Finally, suicide and opioid overdose data are provided. The data sets vary; some data track Barnstable County only and some describe Cape Cod and the Islands.

Table 2-11 compares mortality and hospitalization rates in Barnstable County and Massachusetts for asthma, heart disease, and diabetes. It demonstrates that the mortality and hospitalization rates in Barnstable County were lower than statewide rates except for the asthma-specific mortality rate, which was the same.

The Department of Public Health's Behavioral Risk Factor Surveillance System (BRFSS) collects data on general health

*Table 2-11 Mortality and Hospitalization Rates in Barnstable County*

| | MORTALITY[1] | | HOSPITALIZATION[1] | |
|---|---|---|---|---|
| | BARNSTABLE COUNTY | MASSACHUSETTS | BARNSTABLE COUNTY | MASSACHUSETTS |
| Asthma[2] | 0.6 | 0.6 | 88.5 | 155.5 |
| Heart Disease[3] | 192.1 | 201.6 | 1,244.6 | 1,536.8 |
| Diabetes[4] | 11.4 | 13.2 | 352.8 | 488.5 |

*1 Adjusted by age per 100,000 persons to minimize effects of differences in age and population distributions.*
*2 Mortality rates based on average of 2008-2010 data, hospitalization based inpatient rate from 2007-2009*
*3 Mortality rates based on average of 2008-2010, hospitalization rates based on 2007-2009*
*4 Mortality rates based on 2010, hospitalization based on inpatient rate from 2009*

*Source: Mass Community Health Information Profile from Massachusetts Executive Office of Health and Human Services website (http://www.mass.gov/eohhs/researcher/community-health/masschip).*

*Table 2-12 Population with Sad, Blue, or Depressed Feelings*

| | CAPE COD AND THE ISLANDS | MASSACHUSETTS |
|---|---|---|
| 15+ days of sad, blue, or depressed in the past 30 days among adults | 5.1% | 7.2% |

*Source: MassCHIP from Massachusetts Executive Office of Health and Human Services BRFSS Special Reports: General Health Status for Cape and Islands 2002-2007*

*Table 2-13 Population with Health Risk Factors in Barnstable County*

| | BARNSTABLE COUNTY | MASSACHUSETTS |
|---|---|---|
| Obesity | 15.8% | 19.4% |
| Smoking | 12.8% | 15.0% |

*Source: MassCHIP from Massachusetts Executive Office of Health and Human Services BRFSS Special Reports: Risk Factors and Health Behaviors for Cape and Islands 2006-2009*

*Table 2-14 Suicide Rate in Barnstable County*

| | BARNSTABLE COUNTY | MASSACHUSETTS |
|---|---|---|
| Suicide Rate[1] | 12.1 | 8.7 |

[1] Age-adjusted rate per 100,000 persons

*Source: MDPH Bureau of Communicable Diseases, 2014*

status and asks respondents to report the number of days that they had felt sad, blue, or depressed in the previous 30 days. Fewer Cape and Island residents reported these feelings for 15 or more days in the previous month than residents statewide (Table 2-12).

The BRFSS also reports health-risk factors in adult populations in Massachusetts including obesity and smoking. Table 2-13 provides a comparison of these health risk factors for Barnstable County and Massachusetts and demonstrates that the rates of these conditions for Barnstable County were less than the average statewide rates.

Table 2-14 shows the increase in opioid-related deaths in Massachusetts from 2000 to 2015 (up more than 360%, from 355 to 1,658), with a particularly sharp rise since 2013. Opioidrelated deaths rose even more dramatically in Barnstable County, which experienced a 450% increase from 2000 to 2015.

Two other health issues of note are suicide and Lyme disease. Table 2-14 shows a substantially higher age-adjusted suicide rate on Cape Cod and the Islands than for the entire state. Additionally, since 2000, Barnstable County's suicide rate has nearly doubled, from 6.2 to 12.1 suicides per 100,000 persons.

Overall, hospitalizations and mortality rates from common health problems in Barnstable County is lower than statewide rates. The percent of health-risk factors is also lower in Barnstable County than it is for the state.

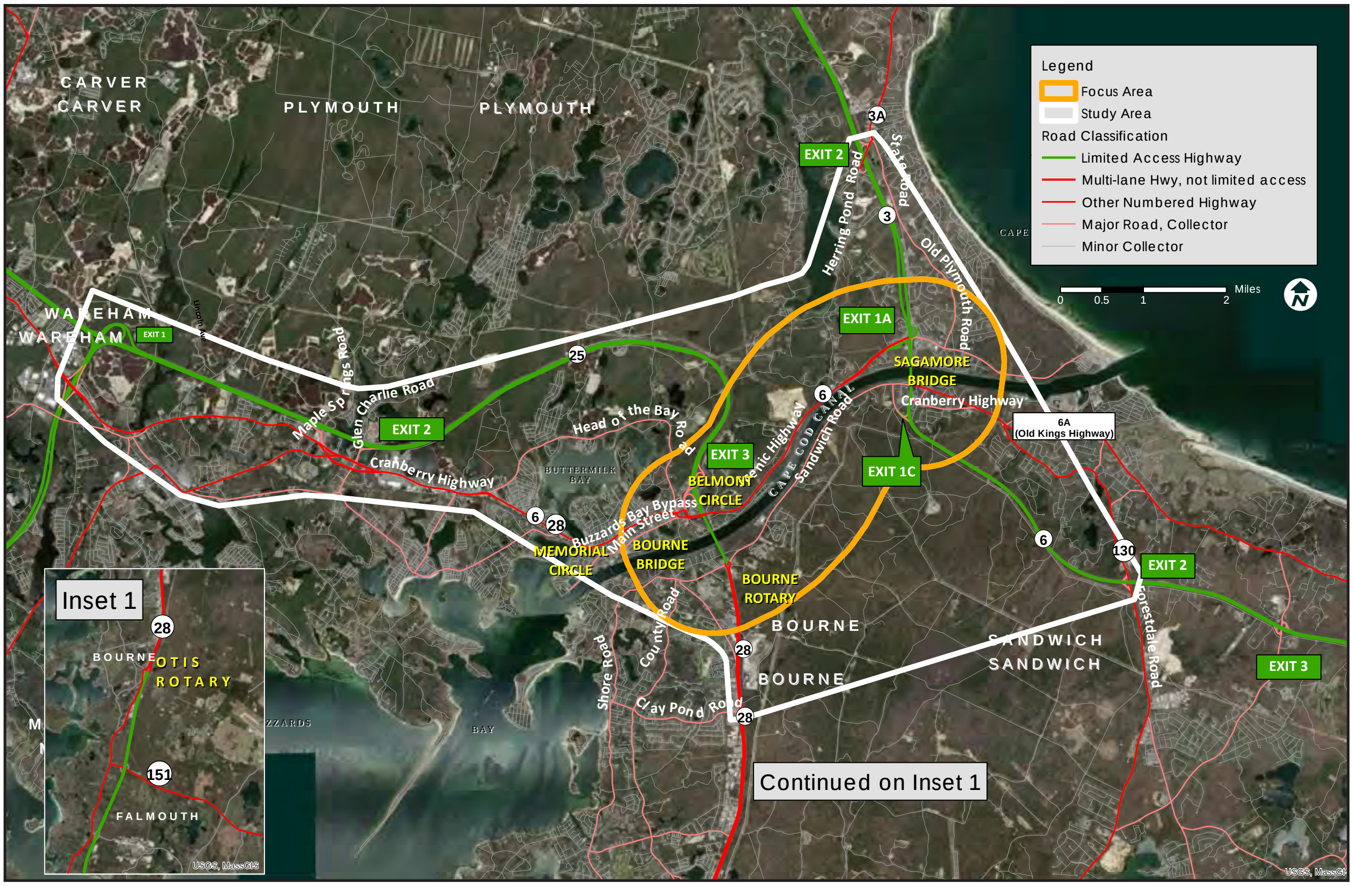



*Exhibit 2-17 Major Roadways in the Study Area*

## 2.5 TRANSPORTATION CONDITIONS

This section describes existing transportation facilities and traffic conditions in the study area. The major roadways and intersections in the study area are shown on Exhibit 2-17.

*(top to bottom)*
*Sagamore Bridge*
*Bourne Bridge*

### 2.5.1 Major Highways in the Study Area

Major highway corridors in the study area include the Route 3/ Sagamore Bridge/Route 6 corridor along the eastern side of the study area and the Route 25/Bourne Bridge/Route 28 corridor along the western side. These two bridges provide the only roadway access to Cape Cod (Exhibit 2-17). These highways are all under MassDOT jurisdiction.

Route 6 (Scenic Highway) and Sandwich Road connect these two corridors on the north and south sides of the Canal, respectively.

#### *Route 3/Sagamore Bridge/Route 6 Corridor*

Route 3, a principal arterial roadway, provides the main highway connection from Boston and other points north to Cape Cod. From the "Braintree Split" (the I-93/Route 3 Interchange in Braintree) south to the Sagamore Bridge, Route 3 generally has

two 12-foot wide travel lanes in each direction with an eight-foot shoulder separated by a grassed median. This configuration continues into the study area from the north at the Route 3/Route 3A Interchange (Exit 2) in Bourne.

Approximately two miles south of the Route 3 Exit 2 at Herring Pond Road interchange, Route 3 passes through the "Sagamore Flyover" (Exit 1A, the interchange of Route 3 with Route 6/Scenic Highway). Approaching this interchange from the north, one of the two travel lanes in Route 3 southbound is dropped to allow travelers from Scenic Highway to merge onto Route 3 at Exit 1A, reinstating the second travel lane. This lane-drop on Route 3 southbound was a required – but less desirable - feature in the design of the 2006 reconstruction of the Sagamore Rotary as a highway interchange because of the need to immediately tie into the two-lane Sagamore Bridge.

South of the Sagamore Rotary the highway designation changes to Route 6 and immediately crosses the Canal on the Sagamore Bridge. The cross section of the Sagamore Bridge includes two 10-foot travel lanes in each direction with no roadway shoulder. A 5-foot wide sidewalk is present on the east side of the bridge. The sidewalk is separated from the roadway by a 12-inch high granite curb.

The roadway geometry in this area, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays on Route 3, especially during peak travel periods.

Immediately south of the Sagamore Bridge, Route 6 Exit 1C provides access to Sandwich Road for eastbound travelers via the Mid-Cape Connector and to Cranberry Highway for westbound travelers. The geometry of Route 6 Exit 1C westbound (at Cranberry Highway) is substandard and not in compliance with current MassDOT highway design standards. The deficiencies of Exit 1C include short acceleration and deceleration lanes, and steep grades approaching the Sagamore Bridge. High traffic volumes are common at the Exit 1entrance ramp to Route 6 westbound because travelers often use Route 6A to Cranberry Highway to bypass congestion on Route 6 westbound.

Route 6 eastbound maintains the same roadway cross section as Route 3 (two 12-foot travel lanes in each direction). Route 6 continues southeast for approximately 3.3 miles to the Route 6/Route 130 Interchange in Sandwich, the southeast point of the study area.

Route 25, Wareham

### *Route 25/Bourne Bridge/Route 28 Corridor*

The Route 25/Bourne Bridge/Route 28 corridor provides access to Cape Cod from the south and west. The northwest corner of the study area begins at the I 495/I-195/Route 25 Interchange in Wareham. Route 25, a principal arterial roadway, provides three 12-foot travel lanes with an eight-foot shoulder in each direction separated by a 90 foot grassed median. From the I-495/I-195 Interchange, Route 25 travels southeast 2.4 miles to the partial interchange with Maple Springs Road and another 0.5 miles to the partial interchange at Glen Charlie Road in Wareham. Together, these two interchanges provide access in all directions and are designated as Exit 2.

Route 25 continues south/southeast for six more miles to the Route 25/Route 6 (Scenic Highway) Interchange in Bourne. Belmont Circle, immediately to the west, can be reached through this interchange. At this point the highway designation changes to Route 28, and the highway immediately crosses the Canal on the Bourne Bridge. The cross section of the bridge is substandard, featuring two 10-foot travel lanes in each direction with no roadway shoulder. A five-foot wide sidewalk is present on the west side of the bridge. The sidewalk is separated from the roadway by a 12-inch high granite curb. Continuing south from the bridge is the Bourne Rotary, which handles traffic from several roadways, including Route 28, Sandwich Road, and Trowbridge Road.

Route 28 is a principal arterial roadway. Within the study area, it comprises two 12 foot travel lanes in each direction with a 10-foot shoulder separated by a 70-foot forested median. Route 28 provides at-grade access to roadways to the west and has turn around ramps every 0.5 miles. Route 28 continues south of the Bourne Rotary for approximately 6.75 miles to the southwest corner of the study area at the Route 151 intersection in Bourne.

## 2.5.2 Local Roadways/Highways and Principal Intersections in the Study Area

The following describes the main local highways/roadways and principal intersections in the study area (Exhibit 2-17).

Scenic Highway (Route 6)

### *Local Roadways/Highways*

*Route 6 (Scenic Highway, Buzzards Bay Bypass, Cranberry Highway)*

Route 6 (Scenic Highway) is a principal arterial roadway under MassDOT jurisdiction that extends along the north side of the Canal from Route 3 at the Sagamore Interchange and continues to the west approximately 3.5 miles to Belmont Circle in Bourne. Scenic Highway provides a connection between the

Sagamore Bridge and the Bourne Bridge. Traveling west from the Sagamore Bridge for approximately one-mile, the roadway is approximately 84 feet wide consisting of two 12-foot travel lanes in each direction with a 16-foot wide median and 10-foot wide shoulders. No marked bicycles lanes or sidewalks are present. West of Bournedale Road, Scenic Highway narrows to approximately 48 feet wide, consisting of two 11-foot wide travel lanes in each direction with no median. Four-foot-wide shoulders are present on the south side of the roadway. No marked bicycle lanes or sidewalks are present. On the west side of Belmont Circle, Route 6 continues west for approximately one mile as Buzzards Bay Bypass. Traveling west, the bypass has two 11-foot wide westbound travel lanes and a single 11-foot wide eastbound lane. No marked bicycle lanes or sidewalks are present. Prior to the St. Margaret's Street intersection, the roadway shifts to two 11-foot wide travel lanes in each direction to Memorial Circle, where it turns northwest and becomes Cranberry Highway.

Cranberry Highway continues northeast for 2.5 miles, entering Wareham at the Cohasset Narrow Bridge. This portion of Cranberry Highway has a cross section of four 11-foot-wide travel lanes, but it drops to a single lane in each direction for one more mile until it reaches the Route 25 interchange at Glen Charlie Road in Wareham. No marked bicycle lanes or sidewalks are present.

*Sandwich Road*

Sandwich Road, a principal arterial roadway owned by the Town of Bourne, extends east-west for approximately 4.7 miles, parallel to the south side of the Canal, from the Route 6A/Route 130 intersection to the Sandwich Road/Trowbridge Road/County Road intersection. Sandwich Road is generally 22 to 24 feet wide, consisting of one 11- or 12-foot-wide lane in each direction with little or no shoulder. No marked bicycle lanes or sidewalks are present. Sandwich Road passes underneath Route 6 at the Sagamore Bridge and provides access to Route 6 eastbound via the Mid-Cape Connector in Bourne and Route 3 via Cranberry Highway. At its western end, Sandwich Road provides access to either Routes 25 or 28 via the Bourne Rotary. An unsignalized left-turn lane is provided as one approaches the Upper Cape Cod Regional Technical School from the east, 0.4 miles east of the Bourne Rotary.

*Sandwich Road at Technical High School*

*Route 6A, Sandwich*

*Route 6A (Old Kings Highway)*

Route 6A, a minor arterial, is a municipal roadway owned by the towns of Bourne and Sandwich. Route 6A extends approximately 1.3 miles from the Route 130/Sandwich Road intersection to

Tupper Road in Sandwich at the eastern edge of the study area. Route 6A is generally 22-feet wide, consisting of two 11-foot travel lanes with no shoulder. This section of Route 6A passes through primarily residential areas containing numerous historic structures within the Old Kings Highway Regional Historic District (Exhibit 2-9). While Route 6A is a designated bicycle route, no marked bicycle lanes or roadway shoulders are present. Sidewalks are present along either one or both sides of Route 6A from the Route 130 intersection to Crowell Lane.

*Route 130 (Main Street)*


Route 130, Sandwich

Route 130 (Main Street), a major collector roadway, is a municipal roadway owned by the town of Sandwich. Route 130 extends approximately 2.9 miles from the Route 6A/Sandwich Road intersection to Route 6 at Exit 2 in Sandwich at the eastern edge of the study area. Route 130 is generally 22-feet wide, consisting of two 11-foot travel lanes with no shoulder. Like Route 6A, this section of Route 130 passes through primarily residential areas containing numerous historic structures within the Old Kings Highway Regional Historic District. Sidewalks are generally present along either one or both sides of Route 130. Other land uses along Route 130 include the Henry Wing School and the Sandwich Landfill.

*Route 151*

Route 151, Falmouth

Route 151 is a major collector roadway that extends approximately 6.6 miles from the Route 28/Great Neck Road intersection in Mashpee east to the Otis Rotary. Route 151 is owned by the towns of Falmouth and Mashpee. Route 151 is generally 22-feet wide, consisting of two 11-foot travel lanes with a four foot shoulder on both sides of the roadway. Land uses along Route 151 include the Barnstable County Fairgrounds and Mashpee Commons retail center. Sidewalks are not present. A 10 foot wide bike trail runs alongside a portion of the north side of Route 151. The trail extends 0.75 miles from Old Barnstable Road to Job's Fishing Road.

### Principal Intersections (Gateway Intersections)

The principal intersections in the study area are Belmont Circle, Bourne Rotary, and Route 6 Exit 1C. Because these intersections lead motorists directly to and from Cape Cod via the Bourne and Sagamore Bridges. For this reason, for this study they are known as the 'Gateway Intersections'. Because each of these gateway intersections suffers from substandard design features and high peak period traffic volumes, they are a main driver of traffic congestion in the study area.

*Belmont Circle*

*Belmont Circle, Bourne*

Belmont Circle is a rotary north of the Cape Cod Canal immediately west of the Route 25 approach to the Bourne Bridge in Bourne. The roadway approaches to Belmont Circle include Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the ramps to Route 25. The entrance ramp to Route 25 eastbound leads directly to the Bourne Bridge. Upon entering the bridge, the roadway designation changes to Route 28 and continues southeast to other Cape Cod destinations in Bourne, Falmouth, Mashpee, and Chatham. Route 28 also provides access to the Massachusetts Steamship Authority's Woods Hole ferry terminal which provides access to the islands of Martha's Vineyard and Nantucket.

East of Belmont Circle, Main Street becomes Scenic Highway at the Nightingale Pond Road intersection. Scenic Highway provides direct access to Route 3 at the Sagamore Interchange, 3.4 miles to the east.

To avoid traffic congestion on Route 25 eastbound while heading toward the Bourne Bridge, travelers often leave Route 25 at Exit 2 (Glen Chen Charlie Road) to access Route 6 eastbound in Wareham towards Main Street and Belmont Circle in Bourne. A strong traveler preference for Main Street eastbound rather than the parallel route of the Buzzards Bay Bypass has been observed. This traffic diversion contributes to additional traffic volumes in Belmont Circle.

The roadway approaches to Belmont Circle generally consist of a single 11 foot lane in each direction. Scenic Highway features two 11-foot lanes in each direction. The rotary itself generally features three 12-foot lanes. The Main Street approach has parking on both sides of the road. No marked bicycle lanes or sidewalks are present.

Several restaurants and retail businesses, including CVS pharmacy, Ocean State Job Lot, the Way-Ho restaurant, and Mobil Gas have driveways directly from the Circle. Traveling west on Main Street from Belmont Circle leads directly to the Bourne business district.

*Bourne Rotary, Bourne*


*Bourne Rotary*

The Bourne Rotary is immediately south of the Bourne Bridge. The roadway approaches to the Bourne Rotary include Route 28 (on both the north and south sides of the Rotary), Trowbridge Road, and the Bourne Rotary Connector. Sandwich Road provides a roadway connection north of the rotary between Trowbridge Road (via Veterans Way) and the Bourne Rotary Connector.

Sandwich Roads provides a connection to Route 6 (via the Mid Cape Connector) 3.0 miles to the east.

Route 28 north of the Bourne Rotary leads directly to the Bourne Bridge. Upon exiting the bridge, the roadway designation changes to Route 25 and continues northwest to other destination in southeastern Massachusetts and Rhode Island.

The roadway cross section along Route 28 approach from the north includes two 10 foot travel lanes in each direction with no roadway shoulder. A five-foot wide sidewalk exists on the west side of the Bourne Bridge. In 2017, MassDOT extended this sidewalk to the south around the front of the State Police barracks to Veterans Way. Other than this sidewalk at the State Police barracks, no other sidewalks or marked bicycle lanes are present. The cross section of the Route 28 approach from the south consists of two 12 foot travel lanes in each direction with a 10-foot shoulder separated by a 70-foot forested median. The Trowbridge Road approach to the rotary consists of a single 12-foot lane in each direction. Finally, the Bourne Rotary Connector approach to the rotary consists of a single 16-foot lane in each direction.

*Route 6 Exit 1C Westbound*

Route 6 Exit 1C

Route 6 Exit 1C includes westbound-only exit and entrance ramps to and from Cranberry Highway in Bourne. The highway ramps are immediately south of the Sagamore Bridge. The Christmas Tree Shop retail store is adjacent to the Exit 1C entrance ramp. At approximately 200 feet, these exit- and entrance-ramps are substandard in length. MassDOT Highway Design standards recommend 600-foot exit ramps and 1,000-foot entrance ramps.

The roadway geometry at the Route 6 Exit 1C entrance ramp, including the substandard acceleration lane and steep grades on the Sagamore Bridge approach, contributes to congestion and delays on Route 6 westbound, especially during peak travel periods.

***Automatic Traffic Recorders (ATRs)*** *are pneumatic tubes placed across a roadway that record the number and type of all vehicles that pass over them.*

***Turning Movement Counts (TMCs)*** *are conducted at intersections to determine how many and what types of vehicles approach an intersection and what direction they head to.*

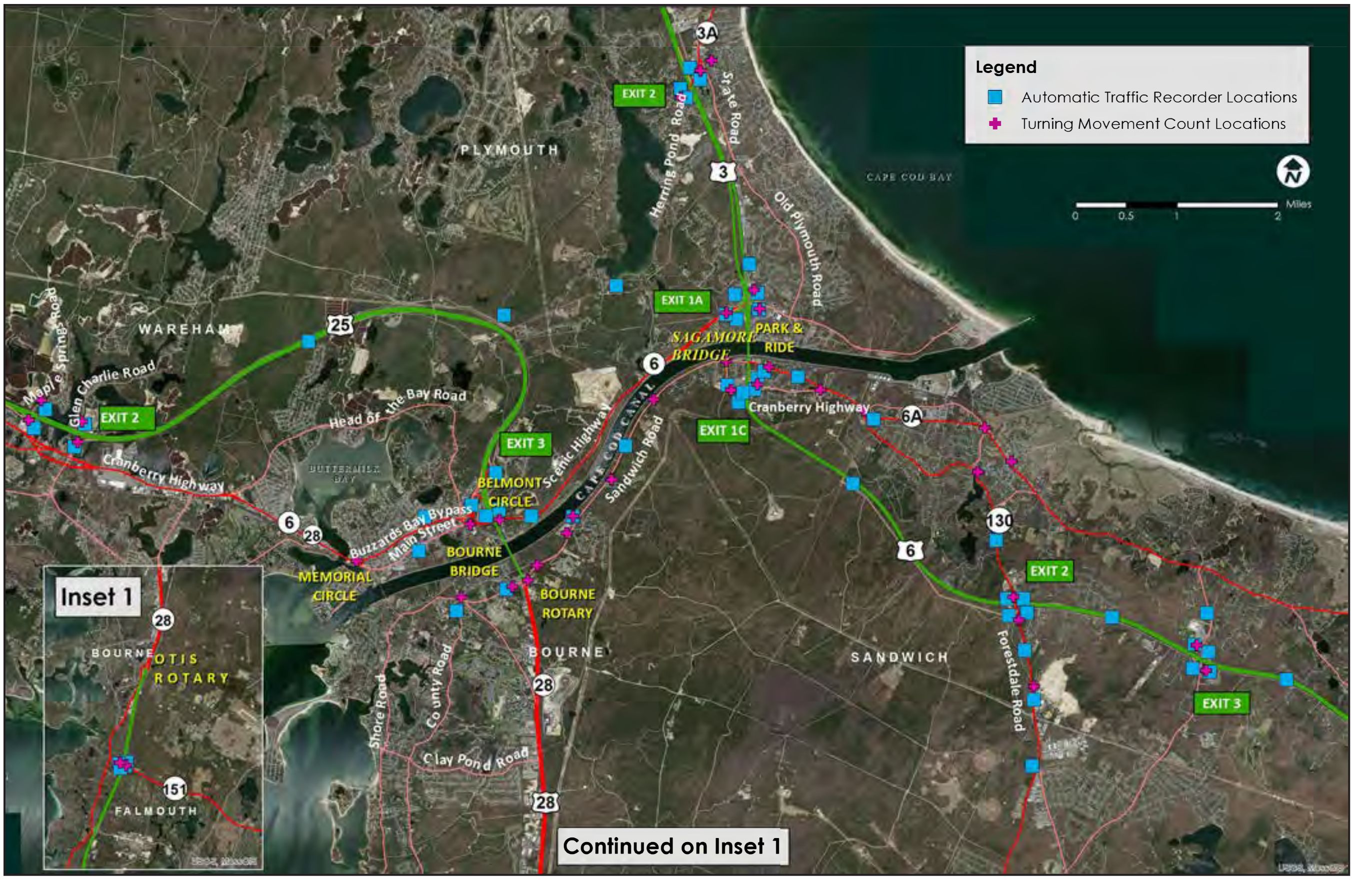



*Exhibit 2-18 Location of Automatic Traffic Recorders and Turning Movement Counts*

### 2.5.3 Traffic Counting Methods

The study team collected traffic data in the study area using methods that include Automatic Traffic Recorders (ATRs), Turning Movement Counts (TMCs), and BlueTOAD™ origin-destination study.

Traffic data along highways, local roadways and numerous intersections was collected using a combination of all three methods. Traffic counts were collected using ATRs at 57 locations and conducted TMCs at 37 locations in or close to the study area (Exhibit 2-18). These data identified average daily traffic (ADT), peak-hour volumes, and the turning movements of vehicles in the study area.

Traffic data is presented for two different time periods, the peak period and the peak hour. Traffic data is collected during the peak period, typically a two-hour period. This data is used to identify the one-hour period with the highest traffic volume. The subsequent traffic analysis uses the peak hour traffic volumes to evaluate capacity and Level of Service (LOS).

### *Automatic Traffic Recorders and Turning Movement Counts*

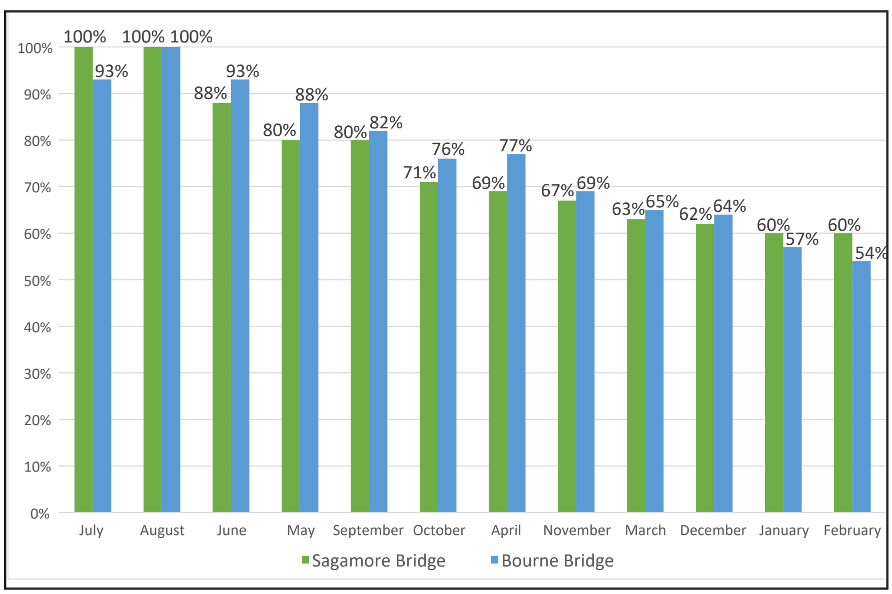
Automatic Traffic Recorders (ATRs) comprise pneumatic tubes laid across a roadway perpendicular to the line of travel. As vehicles pass over the tube, a recording device stores the number of vehicles that pass over during certain time intervals. Turning Movement Counts are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow traffic engineers to assign a LOS for that location (as described in Section 2.5.5).

Turning Movement Counts (TMCs) were conducted at roadway intersections, including signalized and stop-controlled intersections, roundabouts, and rotaries. Turning Movement Counts determine how many and what type of vehicles approach an intersection and what direction they head to (left, right, or through). This count is taken for all roadway approaches. The TMCs were conducted by hand counts and they include pedestrian and bicycle traffic.

The study team collected traffic data during a summer period and a non summer period in 2014. The summer period data collection occurred August 10–17 and the non summer collection took place October 19–26, as these months were found to be representative of these periods.

The summer and non-summer collection periods reflect the reality of Cape Cod traffic patterns: as a major summer tourist destination, it has far higher traffic volumes in the summer than in the non-summer periods. For example, as shown on Exhibit 2-19, the average traffic volumes crossing the Canal Bridges during February are only 54% (Bourne Bridge) to 60% (Sagamore Bridge) of the volumes crossing these bridges during August.

***Exhibit 2-19 Seasonal Traffic Volumes Differences on Canal Bridges***



Traffic data was collected for summer Saturday peak period, a period of high traffic demand because vacation rentals on the Cape generally begin and end on Saturday. Summer Saturdays are a period of high bi-directional volumes with traffic traveling both to and leaving from Cape Cod. Based on the traffic data collected during these two-hour travel periods, the peak one-hour period is identified. The data from this peak hour was used to inform the study's traffic analysis.

The time periods examined were:

- AM summer weekday (7:00 AM – 9:00 AM)
- PM summer weekday (4:00 PM – 6:00 PM)
- Saturday summer (10:00 AM - 12:00 PM)
- AM non-summer weekday (7:00 AM – 9:00 AM)
- PM non-summer weekday (4:00 PM – 6:00 PM)
- Saturday non-summer (10:00 AM - 12:00 PM)

***A BlueTOAD™ unit performs detailed origin-destination studies by detecting the unique Bluetooth number of phones, navigation, and other GPS-based devices as they enter and exit a Study Area.***


*A BlueTOAD™ unit*

### 2.5.4 BlueTOAD™ Origin-Destination Study

The study area presents two sets of unique decision locations not found in most transportation studies. These are the access control represented by the two highway bridge crossings of the Cape Cod Canal and the multiple exit-entrance choices afforded by study area rotaries.

Understanding travel routing in the study area requires an understanding of the travel patterns of vehicles using the roadway network. That emerges from origin-and-destination data collected from vehicles as they enter and exit the roadway. A seven-day origin-destination study was conducted using BlueTOAD™ units and ATRs to gain an understanding of the origins and destinations of traffic in the study area. For example, the BlueTOAD™ study allowed for a better understanding of which roads a vehicle used to travel from Route 25 eastbound in Wareham to Route 6 eastbound in Sandwich.

A BlueTOAD™ unit records the unique Bluetooth number of GPS-enabled devices (cell phones, navigation, and car radios), then records where these devices pass by the BlueTOAD™ units installed throughout the study area. This technology collects information on approximately 10% to 15% of the total traffic


*Exhibit 2-20 Location of BlueTOAD™ Units*

volume, a level of sampling considered sufficient to estimate origins and destinations for all traffic.

Exhibit 2-20 shows the location of BlueTOAD™ devices throughout the study area for two one-week recording periods: in July 2014 during the peak season and in October 2014 during the non-peak season. Each deployment coincided with ATR data collection. The study team applied the percentages determined by the BlueTOAD™ data to the coinciding traffic counts from ATRs and TMCs, yielding the origins and destinations of all vehicles entering and exiting the study-area roadway network.

### 2.5.5 Transportation Analysis Methodology

The analyses of study area highway operations primarily used Highway Capacity Manual Software (HCS) and other methodologies based on the Highway Capacity Manual (HCM) to calculate levels of service and other measures of effectiveness of roadway operations for major highways. Synchro™ Version 8 was used to analyze signalized and unsignalized intersection operations and SimTraffic software was used to produce simulations. Belmont Circle, the Bourne Rotary, and other traffic circles in the study area were simulated using VISSIM™ software and analyzed using SIDRA™ 5.1 software. These traffic analysis

techniques are accepted by the Federal Highway Administration (FHWA) and state Departments of Transportation nationwide, including MassDOT.

**Level of Service (LOS)**, identified in the Highway Capacity Manual (2016 edition), is a commonly accepted measure of the efficiency for peak-hour traffic operating conditions. Level of Service accounts for such factors as automobile and truck volumes, roadway capacity, speeds, grades, traffic control devices, the progression of vehicular traffic flow along an arterial roadway, roadway types, roadway widths and geometric layouts, as well as anticipated delays. LOS range from A, the optimal free-flow condition, to F, where traffic demands are beyond roadway capacity or create excessive delays (Table 2-15).

*Table 2-15 Level of Service (LOS) Criteria*[1]

| FREEWAY FACILITIES | | |
|---|---|---|
| LEVEL OF SERVICE | DENSITY (PC/MI/LN) | |
| A | < 11 | |
| B | > 11 – 18 | |
| C | > 18 – 26 | |
| D | > 26 – 35 | |
| E | > 35 – 45 | |
| F | > 45 or any component $v_d/c$ ratio > 1.00 | |
| **SIGNALIZED INTERSECTIONS** | | |
| CONTROL DELAY (S/VEH) | LOS BY VOLUME-TO-CAPACITY RATIO[A] | |
| | <1.0 | >1.0 |
| < 10 | A | F |
| > 10 – 20 | B | F |
| > 20 – 35 | C | F |
| > 35 – 55 | D | F |
| > 55 – 80 | E | F |
| > 80 | F | F |
| **UNSIGNALIZED INTERSECTIONS** | | |
| CONTROL DELAY (S/VEH) | LOS BY VOLUME-TO-CAPACITY RATIO[A] | |
| | <1.0 | >1.0 |
| 0-10 | A | F |
| > 10 – 15 | B | F |
| > 15 – 25 | C | F |
| > 25 – 35 | D | F |
| > 35 – 50 | E | F |
| > 50 | F | F |

*Note: For approach-based and intersection-wide assessments, LOS is defined solely by control delay.*
*Note: The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection.*

*Transportation Research Board, Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis, 2016*

Roadways or intersections operating at LOS F are typically judged 'undesirable'. LOS E has generally become a threshold between acceptable and undesirable traffic operations in urban areas.

Traffic operations are defined by the performance of several components characterized by either uninterrupted flow (highway sections and ramp junctions) or interrupted flow (unsignalized intersections with roadway ramps and arterials or yield-controlled movements at the rotary). In recognition of the distinctly different nature of traffic flow and driver's expectations for these types of traffic facilities, LOS is based on density for highway sections and ramps and average delay at intersections. This concept and the typical characteristics of various components that comprise the roadway network in the study area are explained further in the following paragraphs.

Highway segments or **links** have limited access between interchanges. In these areas, with no ramps, LOS reflects vehicle density per lane, a measure of the spacing between vehicles and the ability of a driver to travel at a desired speed without being delayed by other vehicles on the road. Other measures of effectiveness used to assess operations for links include density in passenger cars per mile per lane (pc/mi/ln) and average passenger car speed in miles per hour.

Ramp junctions are locations where traffic either merges with or diverges from the mainline traffic stream. **Merge movements** occur where vehicles entering the highway from an on-ramp must blend with or merge into the mainline flow. **Diverge movements** occur as a vehicle maneuvers out of the mainline flow and onto an exit ramp. As with links, LOS for merge and diverge sections is a function of the density in the lanes. The main traffic demands are the volumes of merge or diverge traffic and mainline traffic value. A **weave** area occurs as vehicles attempting to enter and where entry and exit points occur close to each other.

### *VISSIM™ vs. HCM*

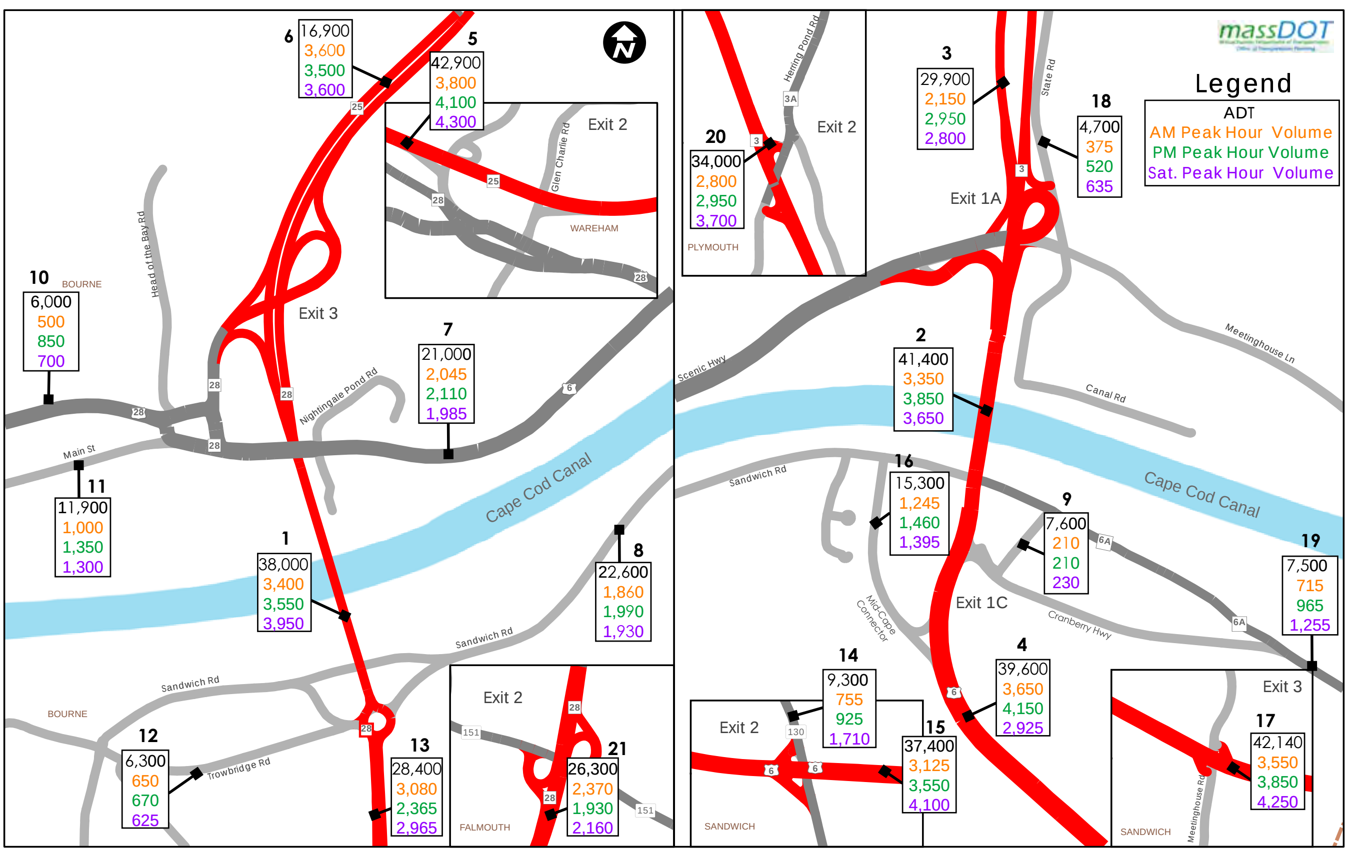
While HCM software determines LOS along highways and at intersections, LOS is not an effective measure of performance at rotaries or other unconventional intersections. To understand how traffic operates in Belmont Circle and the Bourne Rotary (and other rotaries in the study area), VISSIM™ was used to analyze and simulate existing conditions. This highly customizable software can reproduce and predict uncommon roadway conditions more effectively than other industry-standard traffic software.

Therefore, to understand how traffic operates in Belmont Circle and the Bourne Rotary, VISSIM™ software was used to analyze and simulate existing and future conditions. Traffic conditions within these rotaries are described in terms of the VISSIM™ model's output, including queues, vehicle delays, and travel time. The results from the simulation (average delay) are then used to determine LOS based on the criteria in the HCM.

### 2.5.6 Existing Average Daily Traffic and Peak-Hour Traffic Volumes

Exhibits 2-21 and 2-22 present summer and non-summer Average Daily Traffic (ADT) and the AM, PM, and summer peak-hour traffic volumes at select locations in the study area. Table 2-16 offers a summary of peak-hour traffic volumes for the AM, PM and Saturday periods for both summer and non-summer traffic. The morning peak is 7:00-9:00 AM; the afternoon peak is 4:00-6:00 PM; and the Saturday peak is 10:00 am-12:00 PM.

***Exhibit 2-21 Existing Non-Summer Average Daily and Peak Hour Traffic Volumes (AM/PM/Saturday)***



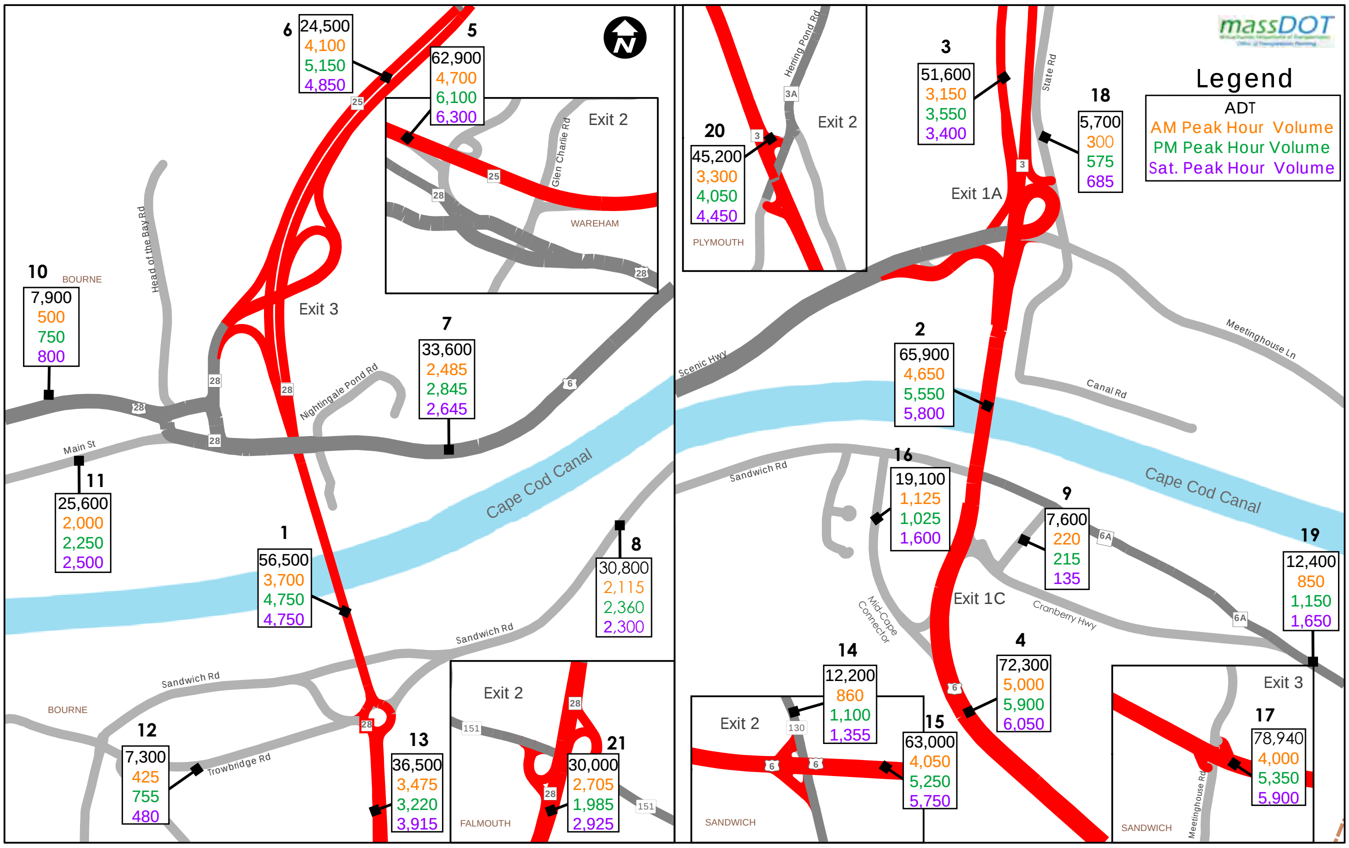



***Exhibit 2-22*** ***Existing Summer Average Daily and Peak Hour Traffic Volumes (AM/PM/Saturday)***

There are substantial seasonal differences in traffic volumes in the study area because Cape Cod is a major summer tourist destination. For example, daily traffic volumes on the Bourne and Sagamore Bridge are 49% and 59% higher in the summer, respectively, compared to non-summer periods. Daily traffic volumes are 45% higher on Route 25 and 83% higher on Route 6 during the summer (Table 2-17).

Certain count locations were excluded from the table as they were outside of the focus area or did not contribute meaningfully to the study. These locations are:

- Herring Pond Road South of Black Pond Road
- Route 130/Main Street North of Pickerel Cove Road
- Bournedale Road over Route 25
- Route 130 South of Kiahs Way
- Shore Road West of County Road
- Driveway from Cranberry Highway to the Christmas Tree Shop
- Quaker Meeting House Road North of Route 6

*Table 2-16 Existing Average Daily Traffic Volumes and Peak Hour Traffic Volumes*

| | | SUMMER 2014 | | | | NON-SUMMER 2014 | | | |
|---|---|---|---|---|---|---|---|---|---|
| EXHIBIT LOCATION (2-21 / 2-22) | ATR COUNTING STATIONS | AM | PM | SAT | ADJUSTED ADT[1] | AM | PM | SAT | ADJUSTED ADT[1] |
| 1 | Bourne Bridge | 3,700 | 4,750 | 4,750 | 56,500 | 3,400 | 3,550 | 3,950 | 38,000 |
| 2 | Sagamore Bridge | 4,650 | 5,550 | 5,800 | 65,900 | 3,350 | 3,850 | 3,650 | 41,400 |
| 3 | Route 3 between Exits 1A and 2 | 3,150 | 3,550 | 3,400 | 51,600 | 2,150 | 2,950 | 2,800 | 29,900 |
| 4 | Route 6 between Exits 1 and 2 | 5,000 | 5,900 | 6,050 | 72,300 | 3,650 | 4,150 | 2,925 | 39,600 |
| 5 | Route 25 West of Exit 2 | 4,700 | 6,100 | 6,300 | 62,900 | 3,800 | 4,100 | 4,300 | 42,900 |
| 6 | Route 25 East of Exit 2 | 4,100 | 5,150 | 4,850 | 24,500 | 3,550 | 3,500 | 3,600 | 16,900 |
| 7 | Route 6 (Scenic Hwy) East of Nightingale Rd | 2,485 | 2,845 | 2,645 | 33,600 | 2,045 | 2,110 | 1,985 | 21,000 |
| 8 | Sandwich Rd East of Bourne Rotary Connector | 2,115 | 2,360 | 2,300 | 30,800 | 1,860 | 1,990 | 1,930 | 22,600 |
| 9 | Adams St South of Sandwich Rd | 220 | 215 | 135 | 7,600 | 210 | 210 | 230 | 7,600 |
| 10 | Buzzards Bay Bypass | 500 | 750 | 800 | 7,900 | 500 | 850 | 700 | 6,000 |
| 11 | Main St West of Perry Ave | 2,000 | 2,250 | 2,500 | 25,600 | 1,000 | 1,350 | 1,300 | 11,900 |
| 12 | Trowbridge Rd West of Veterans Way | 425 | 755 | 480 | 7,300 | 650 | 670 | 625 | 6,300 |
| 13 | Route 28 South of Bourne Rotary | 3,475 | 3,220 | 3,915 | 36,500 | 3,080 | 2,365 | 2,965 | 28,400 |
| 14 | Route 130 North of Route 6 | 860 | 1,100 | 1,355 | 12,200 | 755 | 925 | 1,710 | 9,300 |
| 15 | Route 6 between Exit 2 and 3 | 4,050 | 5,250 | 5,750 | 63,000 | 3,125 | 3,550 | 4,100 | 37,400 |
| 16 | Mid-Cape Connector South of Sandwich Rd | 1,125 | 1,025 | 1,600 | 19,100 | 1,245 | 1,460 | 1,395 | 15,300 |
| 17 | Route 6 East of Exit 3 | 4,000 | 5,350 | 5,900 | 78,940 | 3,550 | 3,850 | 4,250 | 42,140 |
| 18 | State Rd North of Ramp to Route 3 NB | 300 | 575 | 685 | 5700 | 375 | 520 | 635 | 4,700 |
| 19 | Route 6A East of Cranberry Hwy | 850 | 1,150 | 1,650 | 12,400 | 715 | 965 | 1,255 | 7,500 |
| 20 | Route 3 between Exits 2 and 3 | 3,300 | 4,050 | 4,450 | 45,200 | 2,800 | 2,950 | 3,700 | 34,000 |
| 21 | Route 28 South of Exit 2 (Route 151) | 2,705 | 1,985 | 2,925 | 30,000 | 2,370 | 1,930 | 2,160 | 26,300 |
| 22 | Route 3 NB Off Ramp to Herring Pond Rd | 100 | 200 | 100 | 1,800 | 100 | 200 | 150 | 1,400 |
| 23 | Route 3 SB Off Ramp to Herring Pond Rd | 250 | 500 | 800 | 4,600 | 400 | 450 | 800 | 2,100 |
| 24 | Route 3 SB Off Ramp to Scenic Highway | 250 | 300 | 300 | 3,400 | 350 | 350 | 450 | 3,500 |
| 25 | Route 6 EB Off Ramp to Mid-Cape Connector | 450 | 600 | 500 | 5,900 | 450 | 500 | 250 | 4,700 |
| 26 | Route 6 EB Off Ramp to Quaker Meeting House Rd | 350 | 200 | 200 | 1,300 | 100 | 150 | 150 | 1,300 |
| 27 | Route 6 EB Off Ramp to Route 130 | 450 | 250 | 450 | 7,000 | 450 | 650 | 400 | 5,600 |
| 28 | Route 6 WB Off Ramp to Cranberry Hwy | 450 | 500 | 450 | 5,500 | 450 | 550 | 400 | 2,500 |
| 29 | Route 6 WB Off Ramp to Meetinghouse Lane EB | 300 | 450 | 300 | 4,700 | 250 | 350 | 300 | 3,300 |

[1] Average Daily Traffic (ADT)

*Table 2-16 continues on the next page.*

*Table 2-16 Existing Average Daily Traffic Volumes and Peak Hour Traffic Volumes*

| EXHIBIT LOCATION (2-21 / 2-22) | ATR COUNTING STATIONS | SUMMER 2014 | | | | NON-SUMMER 2014 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | AM | PM | SAT | ADJUSTED ADT[1] | AM | PM | SAT | ADJUSTED ADT[1] |
| 30 | Route 6 WB Off Ramp to Quaker Meetinghouse Rd | 100 | 200 | 200 | 1,000 | 200 | 350 | 200 | 2,500 |
| 31 | Route 6 WB Off Ramp to Route 130 | 200 | 250 | 300 | 2,200 | 250 | 300 | 750 | 2,400 |
| 32 | Route 6 WB Off Ramp to Scenic Hwy WB | 800 | 1,100 | 1,000 | 11,800 | 700 | 800 | 550 | 7,500 |
| 33 | Route 25 EB Off Ramp to Belmont Circle | 600 | 750 | 700 | 9,000 | 500 | 500 | 400 | 4,700 |
| 34 | Route 25 EB Off Ramp to Maple Springs Rd | 350 | 850 | 1200 | 7,300 | 300 | 650 | 500 | 5,100 |
| 35 | Route 28 NB Off Ramp to Route 151 | 100 | 290 | 185 | | 150 | 245 | 200 | 2,300 |
| 36 | Route 28 SB Off Ramp to Route 151 | 355 | 745 | 580 | | 400 | 600 | 550 | 5,600 |
| 37 | Route 130 On Ramp to Route 6 EB | 200 | 200 | 150 | 2300 | 300 | 200 | 100 | 2,000 |
| 38 | Route 130 On Ramp to Route 6 WB | 500 | 500 | 300 | 9,400 | 550 | 450 | 350 | 4,700 |
| 39 | Route 130 South of Route 6 | 1,620 | 1,900 | 1,685 | 24,500 | 1,655 | 1,805 | 1,690 | 16,900 |
| 40 | Route 151 On Ramp to Route 28 NB | 520 | 550 | 565 | | 620 | 500 | 600 | 5,800 |
| 41 | Route 151 On Ramp to Route 28 SB | 245 | 220 | 220 | | 280 | 200 | 250 | 2,400 |
| 42 | Belmont Circle On Ramp to Bourne Bridge | 700 | 700 | 1,000 | 8,600 | 750 | 700 | 1,000 | 7,000 |
| 43 | Belmont Circle On Ramp to Route 25 WB | 1,000 | 1,050 | 800 | 12,100 | 850 | 800 | 850 | 7,900 |
| 44 | Bourne Bridge Off Ramp to Belmont Circle | 500 | 700 | 400 | 7,200 | 450 | 650 | 600 | 5,900 |
| 45 | Scenic Hwy EB On Ramp to Sagamore Bridge | 650 | 750 | 950 | 9400 | 650 | 550 | 400 | 5,400 |
| 46 | Scenic Hwy WB On Ramp to Sagamore Bridge | 285 | 280 | 700 | 3600 | 275 | 230 | 350 | 2,700 |
| 47 | Sandwich Rd West of Jillian Drive | 1,925 | 2,295 | 2,305 | 31,200 | 1,845 | 1,960 | 1,855 | 24,300 |
| 48 | Sandwich Rd East of Adams St | 770 | 1,225 | 1,430 | 11,700 | 1,010 | 1,220 | 1,065 | 8,900 |
| 49 | Cranberry Hwy On Ramp to Route 6 WB | 450 | 550 | 800 | 6,500 | 400 | 550 | 750 | 5,100 |
| 50 | Mid Cape Connector On Ramp to Route 6 EB | 800 | 1,000 | 1,100 | 12,500 | 700 | 800 | 900 | 8,400 |
| 51 | Herring Pond Rd On Ramp to Route 3 NB | 350 | 350 | 450 | 4,400 | 600 | 300 | 400 | 4,000 |
| 52 | Herring Pond Rd On Ramp to Route 3 SB | 350 | 150 | 100 | 2,500 | 250 | 150 | 150 | 3,800 |
| 53 | Quaker Meeting House Rd On Ramp to 6 EB | 350 | 200 | 200 | 2,700 | 400 | 200 | 200 | 2,500 |
| 54 | Quaker Meeting House Rd On Ramp to Route 6 WB | 100 | 100 | 50 | 1,000 | 150 | 100 | 100 | 1,000 |
| 55 | Glen Charlie Rd On Ramp to Route 25 EB | 150 | 250 | 250 | 2,200 | 350 | 150 | 150 | 1,600 |
| 56 | Maple Springs Rd On Ramp to Route 25 WB | 600 | 700 | 700 | 6,900 | 600 | 400 | 500 | 4,600 |

[1] Average Daily Traffic (ADT)

Table 2-17 Comparison of Non-Summer and Summer Daily Traffic Volumes

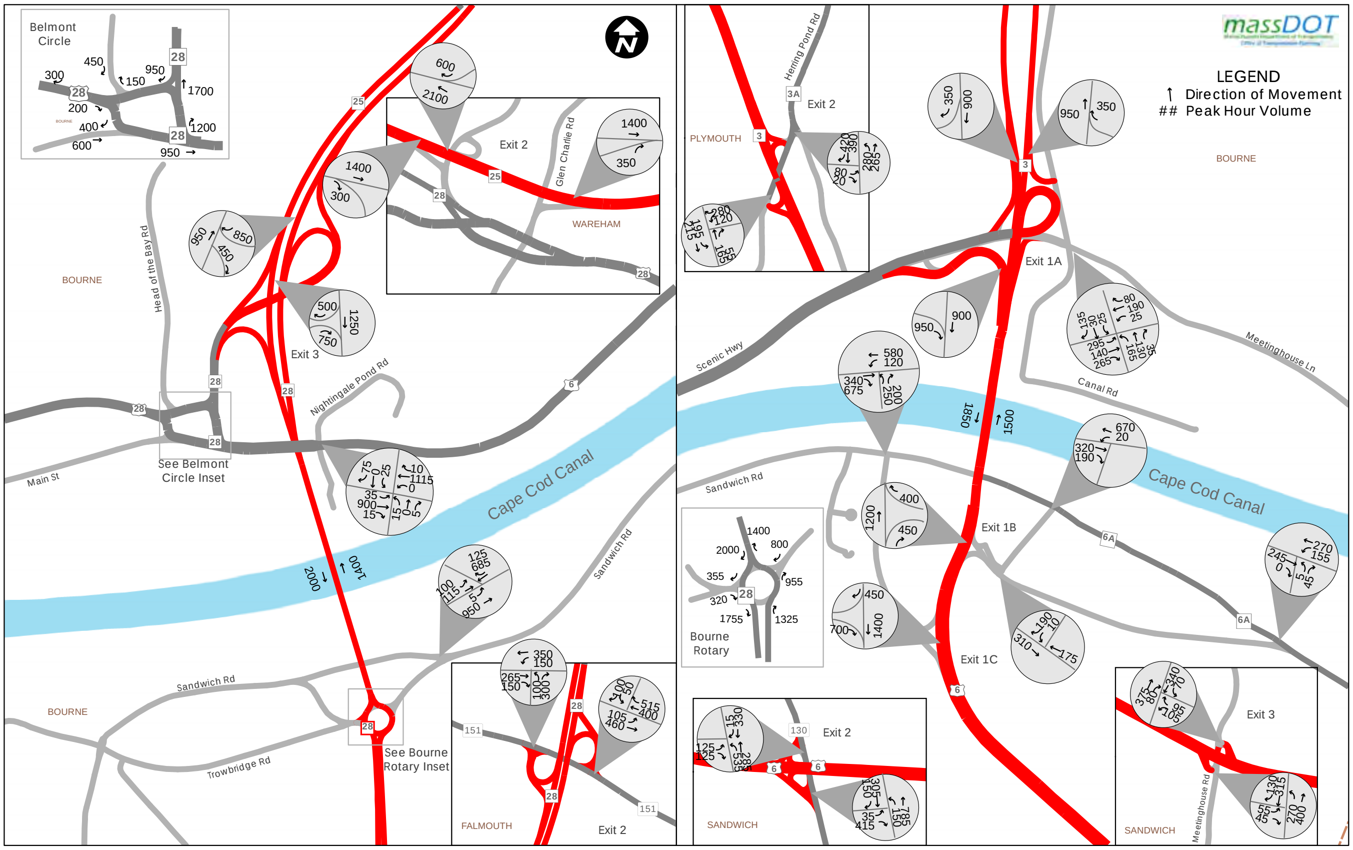
| ATR COUNTING STATIONS | ADJUSTED ADT[1] NON-SUMMER | ADJUSTED ADT[1] SUMMER | PERCENT INCREASE |
|---|---|---|---|
| Bourne Bridge | 38,000 | 56,500 | 49 |
| Sagamore Bridge | 41,400 | 65,900 | 59 |
| Route 3 between Exits 1A and 2 | 29,900 | 46,500 | 56 |
| Route 6 Between Exits 1 and 2 | 39,600 | 72,300 | 83 |
| Route 25 west of Exit 2 | 42,900 | 62,900 | 47 |
| Route 25 east of Exit 2 | 16,900 | 24,500 | 45 |
| Route 6A East of Tupper Road | 7,500 | 12,400 | 65 |
| Route 6 (Scenic Hwy) east of Nightingale Rd | 21,000 | 33,600 | 60 |
| Sandwich Rd East of Bourne Rotary Connector | 22,600 | 30,800 | 36 |
| Main Street, Bourne West of Perry Avenue | 11,900 | 25,600 | 115 |

[1] Average Daily Traffic (ADT)

### 2.5.7 Existing (2014) Turning Movements

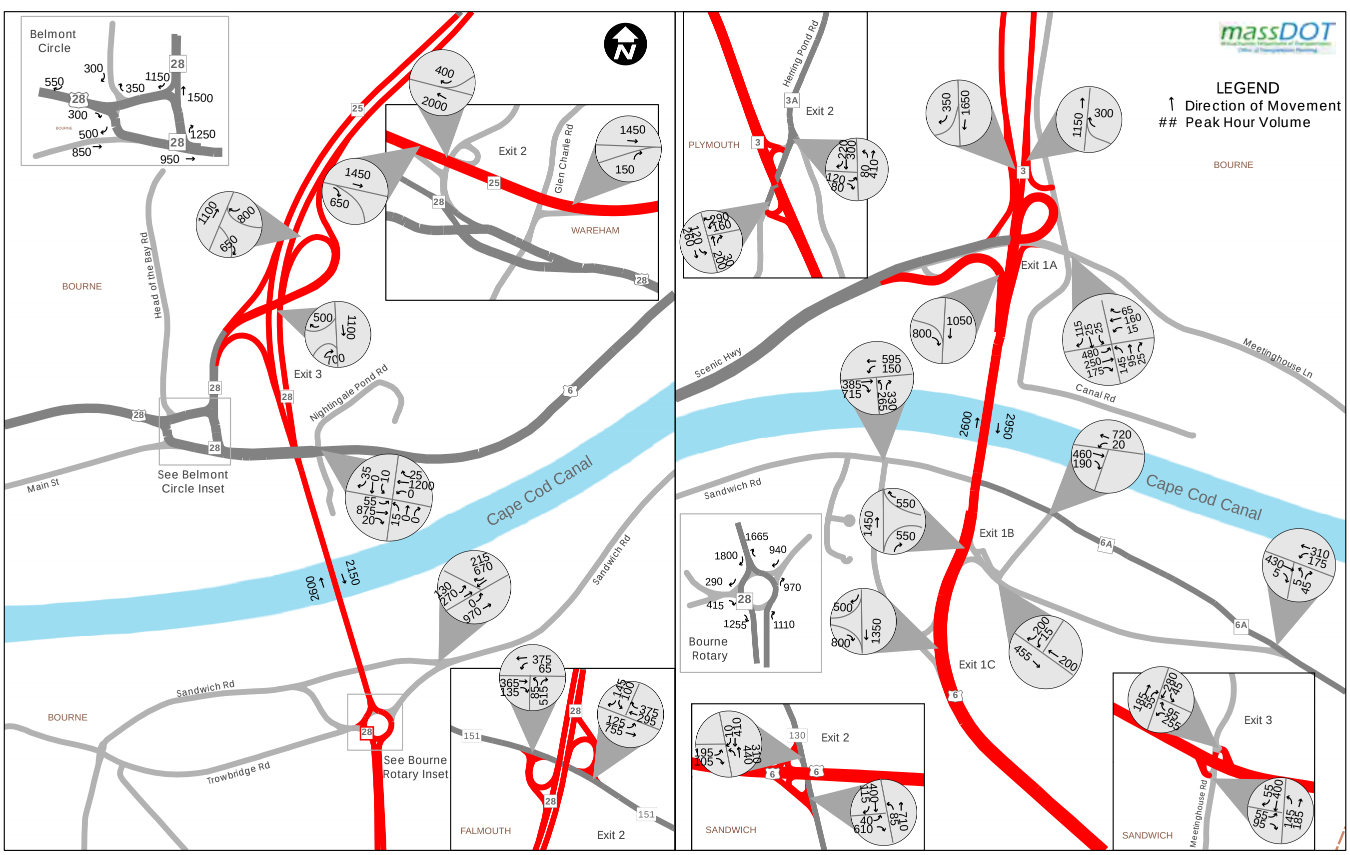
Turning movement counts (TMC) quantify the movement of vehicles traveling through intersections, including signalized, stop-controlled, and rotaries. TMCs are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow for the assignment of LOS for that location. Exhibits 2-23 to 2-28 present vehicle turning movements at intersections in the study area for the various summer and non-summer peak periods. Individual results are provided for the AM, PM, and Saturday peak periods. Certain TMC locations were excluded as they were outside of the focus area or did not contribute meaningfully to the study.

*Text continues on page 2-55.*




## Exhibit 2-23 Existing Non-Summer AM Turning Movements

## Exhibit 2-24 Existing Non-Summer Weekday PM Turning Movements



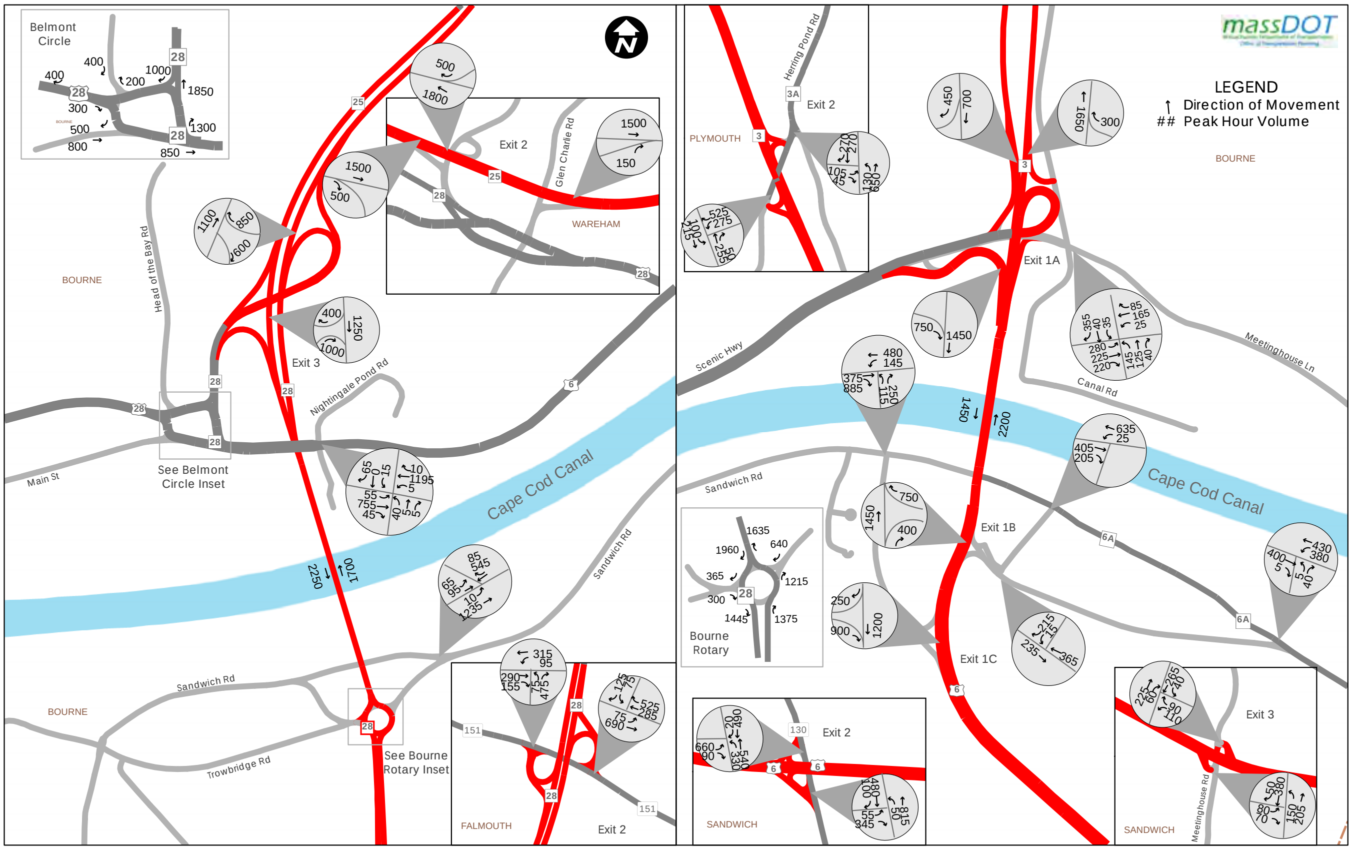
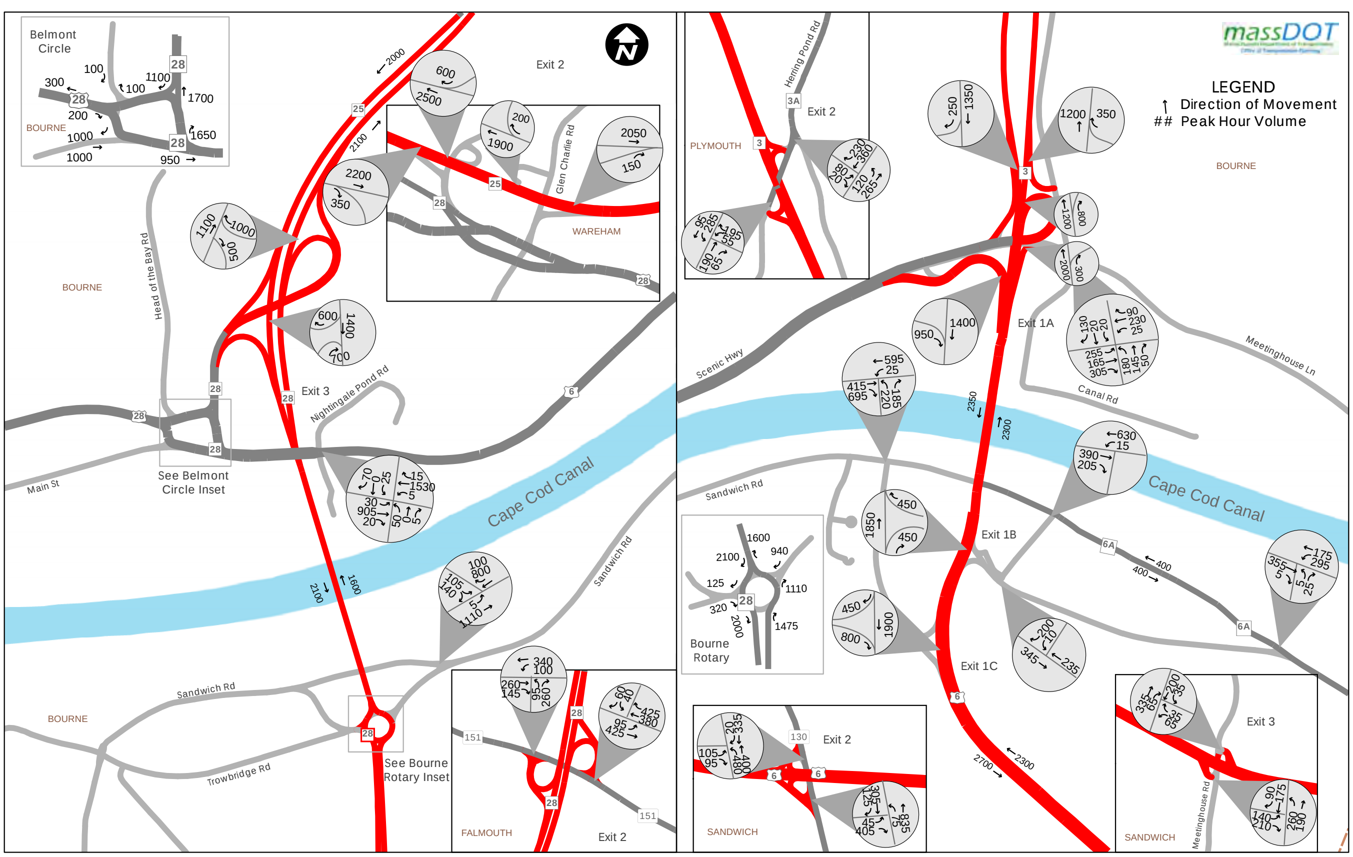



*Exhibit 2-26 Existing Non-Summer Saturday Turning Movements*

*Exhibit 2-25 Existing Summer Weekday AM Turning Movements*



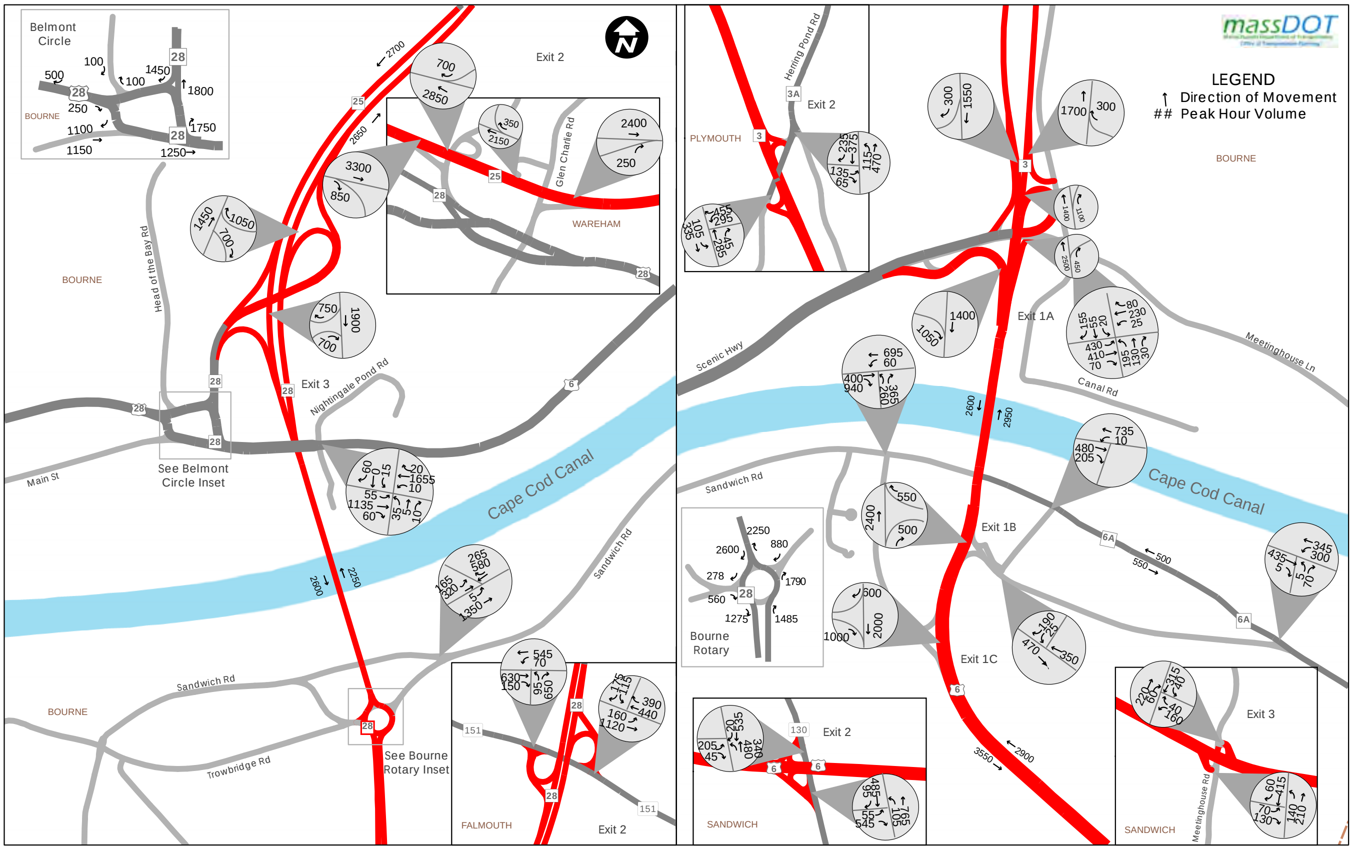
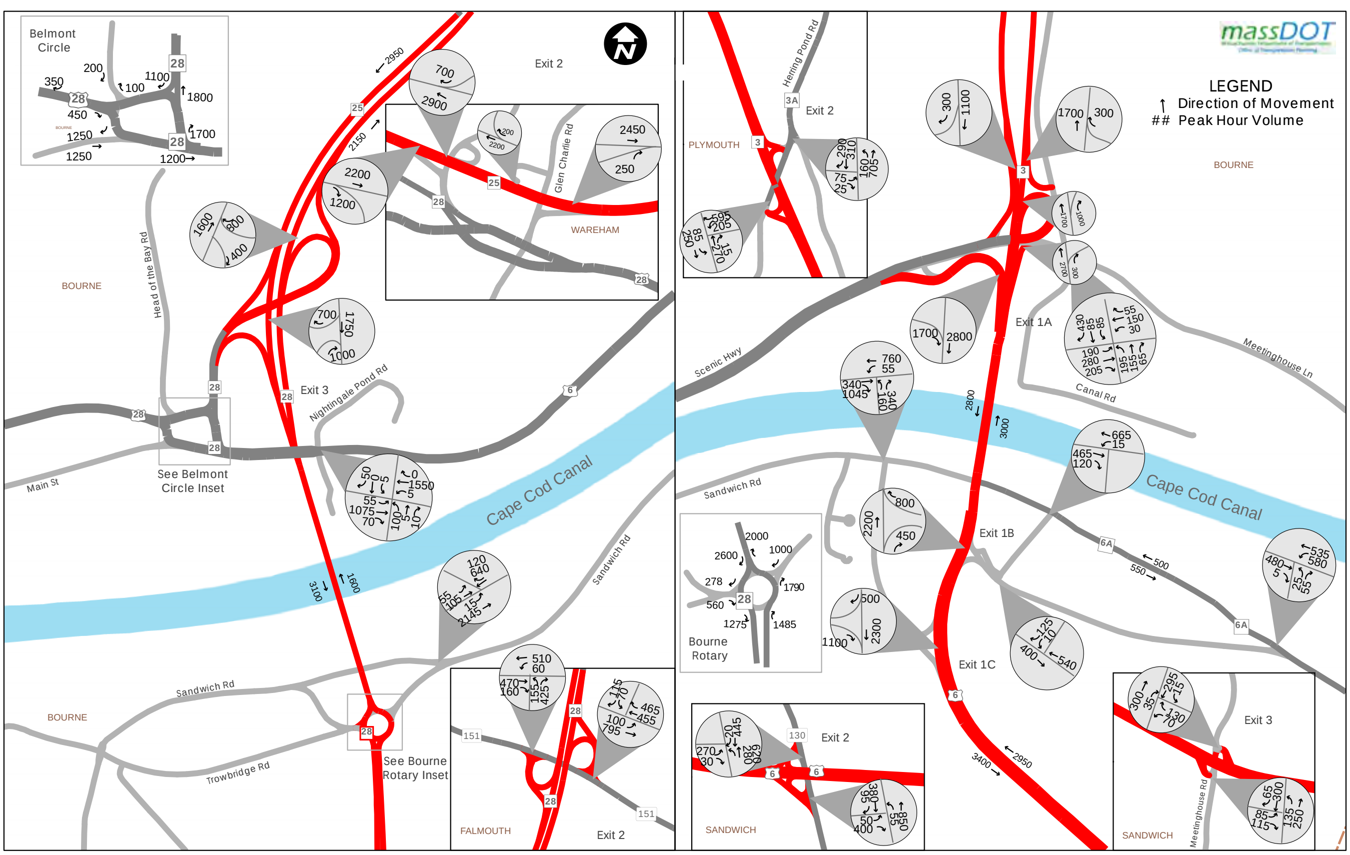



*Exhibit 2-27 Existing Summer Weekday PM Turning Movements*

*Exhibit 2-28 Existing Summer Saturday Turning Movements*



## 2.5.8 Existing (2014) Peak-Hour Levels of Service

Based on the traffic volume counts, peak-hour LOS was analyzed at 50 locations throughout the study area, including six signalized intersections, 15 unsignalized intersections, two rotaries, seven highway links, and 20 highway ramps for the AM and PM weekday peak-periods as well as Saturday mid-day peak hour.

All signalized and stop-controlled intersections were analyzed using Synchro™ Version 8 software and simulated using SimTraffic software. Freeway operations, such as merge, diverge, weave and link analysis were calculated using Highway Capacity Software (HCS) 2010. Finally, Belmont Circle and the Bourne Rotary were simulated using VISSIM™ software and analyzed using SIDRA™ Version 5.1. SIDRA™ provides the overall LOS for the rotaries and traffic circles. The results of this analysis are shown in Tables 2-18 and 2-19. Exhibits 2-29 and 2-30 (freeways) and Exhibits 2-31 through 2-36 (intersections) present the results graphically.

*Text continues on page 2-62.*

*Table 2-18 Existing Levels of Service for Freeway Sections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER WEEKEND | NON-SUMMER WEEKEND |
|---|---|---|---|---|---|---|
| HIGHWAY LINKS | | | | | | |
| Bourne Bridge (NB) | B | B | C | B | C | B |
| Bourne Bridge (SB) | C | C | C | B | C | C |
| Route 25 East Of Exit 2 (EB) | A | A | B | A | B | A |
| Route 25 East Of Exit 2 (WB) | B | A | B | A | B | A |
| Route 25 West Of Exit 2 (EB) | B | A | B | A | B | A |
| Route 25 West Of Exit 2 (WB) | B | A | B | A | B | B |
| Route 3 Between Exits 1A and 2 (NB) | B | A | B | A | B | B |
| Route 3 Between Exits 1A and 2 (SB) | B | A | B | B | B | A |
| Route 6 EB Between Exits 1 & 2 (EB) | C | C | D | C | D | C |
| Route 6 WB Between Exits 1 & 2 (WB) | C | B | D | C | C | B |
| Sagamore Bridge (NB) | C | B | D | C | D | B |
| Sagamore Bridge (SB) | C | B | C | B | C | B |
| HIGHWAY ON-RAMPS | | | | | | |
| Belmont Circle to Route 25 WB | B | B | B | B | B | B |
| Cranberry Highway to Rte. 6 WB (Exit 1C) | C | B | D | B | D | C |
| Route 130 to Route 6 EB | C | B | C | B | D | B |
| Glen Charlie to Rte. 25 EB | B | A | B | A | B | A |

Notes:
LOS E or LOS F locations are **bold**

*Table 2-18 continues on the next page.*

*Table 2-18 Existing Levels of Service for Freeway Sections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER WEEKEND | NON-SUMMER WEEKEND |
|---|---|---|---|---|---|---|
| **HIGHWAY ON-RAMPS (CONTINUED)** | | | | | | |
| Route 130 to Rte. 6 WB | C | B | D | B | C | B |
| Quaker Meeting House Road to Route 6 EB | C | C | C | B | D | B |
| Herring Pond Road to Route 3 NB | B | B | B | B | C | B |
| Herring Pond Road to Route 3 SB | B | B | B | B | B | B |
| Mid Cape Connector to Route 6 EB | C | C | D | C | D | C |
| Quaker Meeting House Road to Route 6 WB | C | B | C | B | C | C |
| Scenic Hwy to Route 6 EB/ Bridge | C | B | C | B | C | B |
| Belmont Circle to Route 25 (Bourne Bridge) | C | C | C | B | C | C |
| **HIGHWAY OFF-RAMPS** | | | | | | |
| Route 25 EB to Maple Springs Road | B | B | C | B | C | B |
| Route 6 EB to Route 130 | D | C | D | C | **E** | C |
| Route 6 WB to Route 130 | C | B | D | B | D | C |
| Route 6 EB to Mid-Cape Connector | C | B | C | B | D | B |
| Route 6 EB to Quaker Meeting House Road | C | C | C | B | D | B |
| Route 6 WB to Quaker Meetinghouse Road | C | B | D | C | D | C |
| Route 6 WB (Exit 1) to Cranberry Hwy | C | B | D | C | D | C |
| Route 25 EB to Belmont Circle | B | B | B | A | B | A |
| Route 3 NB to Herring Pond Road | B | A | B | B | B | B |
| Route 3 SB to Herring Pond Road | B | B | C | B | C | B |
| Bourne Bridge to Belmont Circle | A | A | B | B | B | B |
| Route 3 SB to Scenic Highway | B | B | B | B | B | B |
| Route 6 WB (Sagamore Bridge NB) to 6 WB/ Scenic Hwy | C | B | C | B | D | C |
| Route 6 WB (Sagamore Bridge NB) to Meeting House Road | C | B | D | C | D | C |

Notes:
LOS E or LOS F locations are **bold**

Table 2-19 *Existing Levels of Service at Selected Intersections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER WEEKEND | NON-SUMMER WEEKEND |
|---|---|---|---|---|---|---|
| **SIGNALIZED INTERSECTIONS** | | | | | | |
| Scenic Hwy at Church Lane | B | C | B | C | C | D |
| Meetinghouse Lane, State Rd, and Canal Rd | C | C | **F** | D | C | F |
| Scenic Highway at Nightingale Pond Rd/Andy Olivia Dr | A | A | A | A | B | A |
| Route 6 EB Off Ramp (Exit 2) at Route 130 | B | B | B | A | B | A |
| **UNSIGNALIZED INTERSECTIONS** | | | | | | |
| Sandwich Rd at Bourne Rotary Connector | **F** | **F** | **F** | **F** | **F** | **F** |
| Sandwich Rd at High School Drive | **F** | **F** | **F** | **F** | **F** | **F** |
| Sandwich Rd at Harbor Lights Rd | **F** | **E** | **F** | **F** | **F** | **F** |
| Sandwich Rd at Jarvis Drive | C | **F** | A | **E** | B | C |
| County Road, Sandwich Road, and Trowbridge Road | C | C | F | **E** | C | C |
| Route 28 NB Off-ramp at Route 151 | C | D | **F** | **E** | **E** | C |
| Route 28 SB Off-ramp at Route 151 | C | D | **F** | D | **F** | C |
| Sandwich Rd, Cranberry Hwy, and Regency Drive | E | C | **F** | **E** | **F** | C |
| Old Kings Hwy at Main Street | B | B | C | C | D | B |
| Route 6A at Main Street | A | A | A | A | A | A |
| Maple Springs Rd at Route 25 EB | B | A | D | B | F | B |
| Route 130 at Cotuit Rd | **F** | **E** | **F** | **F** | **F** | **F** |
| Herring Pond Rd at State Rd | D | **E** | **F** | **F** | **F** | **F** |
| Belmont Circle | **F** | **F** | **F** | **F** | **F** | **F** |
| Bourne Rotary | **F** | **F** | **F** | **F** | **F** | **F** |
| Route 6 EB Off Ramp (Exit 3) Quaker Meeting House Rd | D | **E** | D | D | D | C |
| Route 3 SB Off Ramp at Exit 2/Herring Pond Rd | D | D | **F** | D | **E** | D |
| Route 130 (Main St) at Tupper Rd | B | D | D | C | **E** | **E** |

Notes:
LOS E or LOS F locations are **bold**

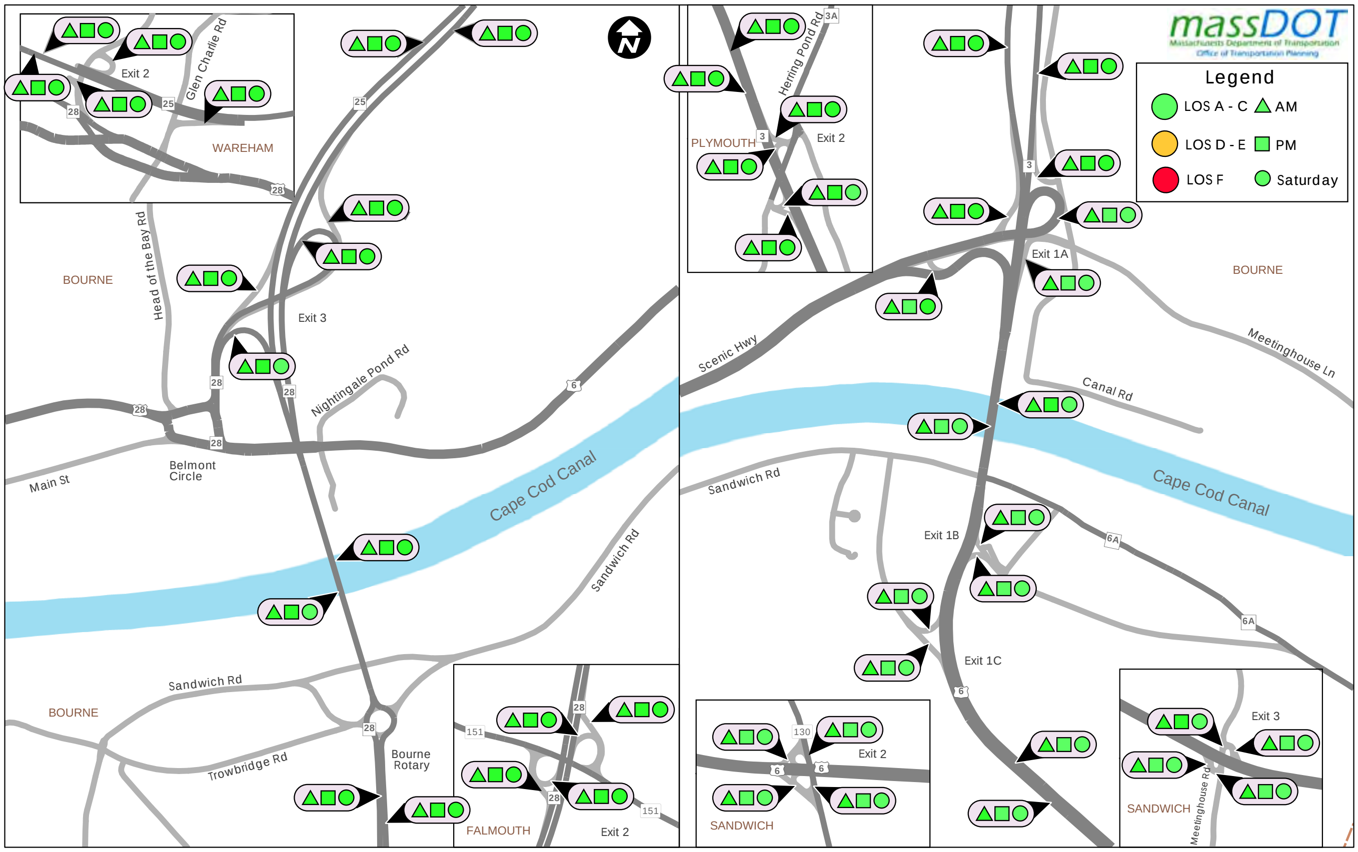
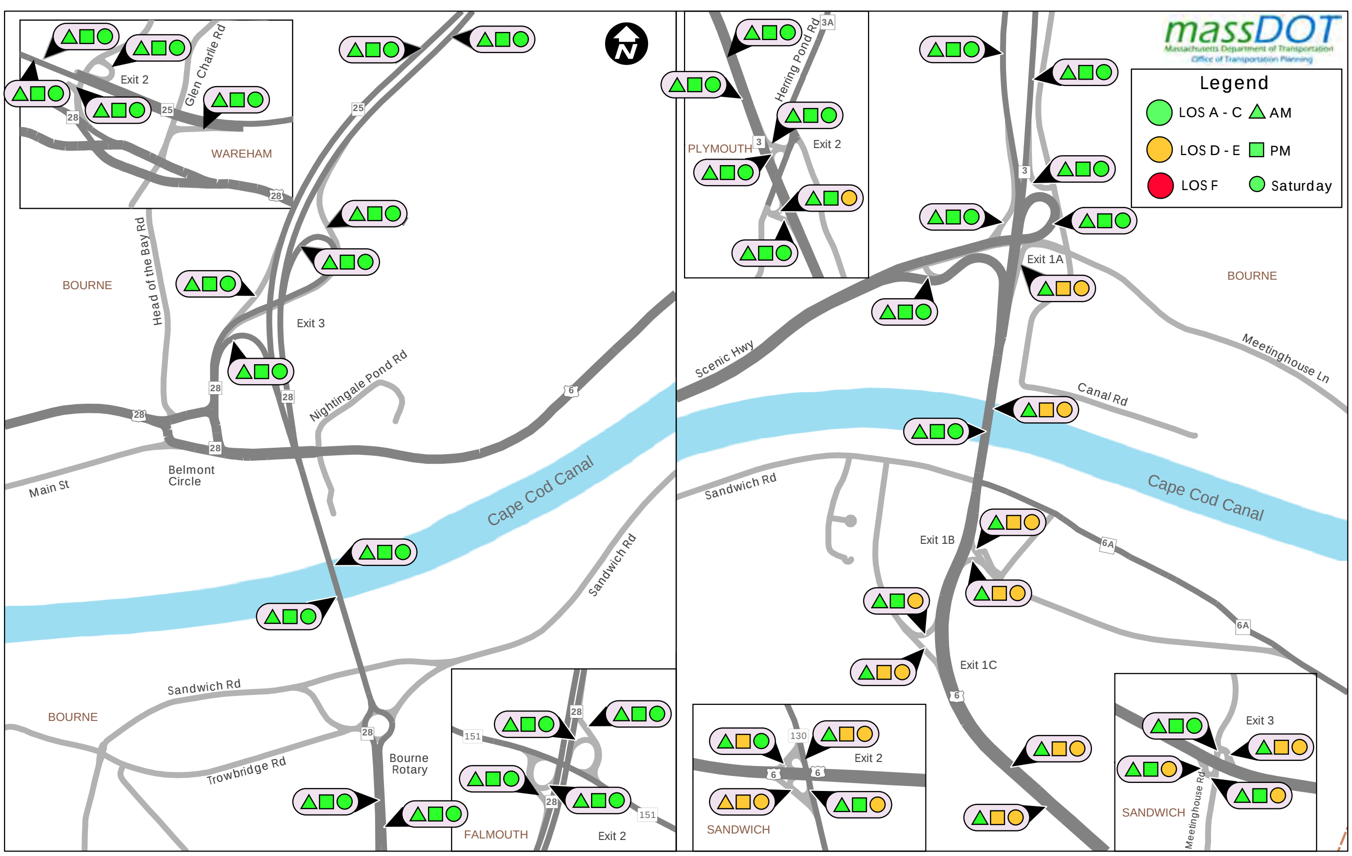



*Exhibit 2-29 Existing Non-Summer Levels of Service - AM/PM/Saturday Peak Hour (Freeway)*

*Exhibit 2-30 Existing Summer Levels of Service - AM/PM/Saturday Peak Hour (Freeway)*



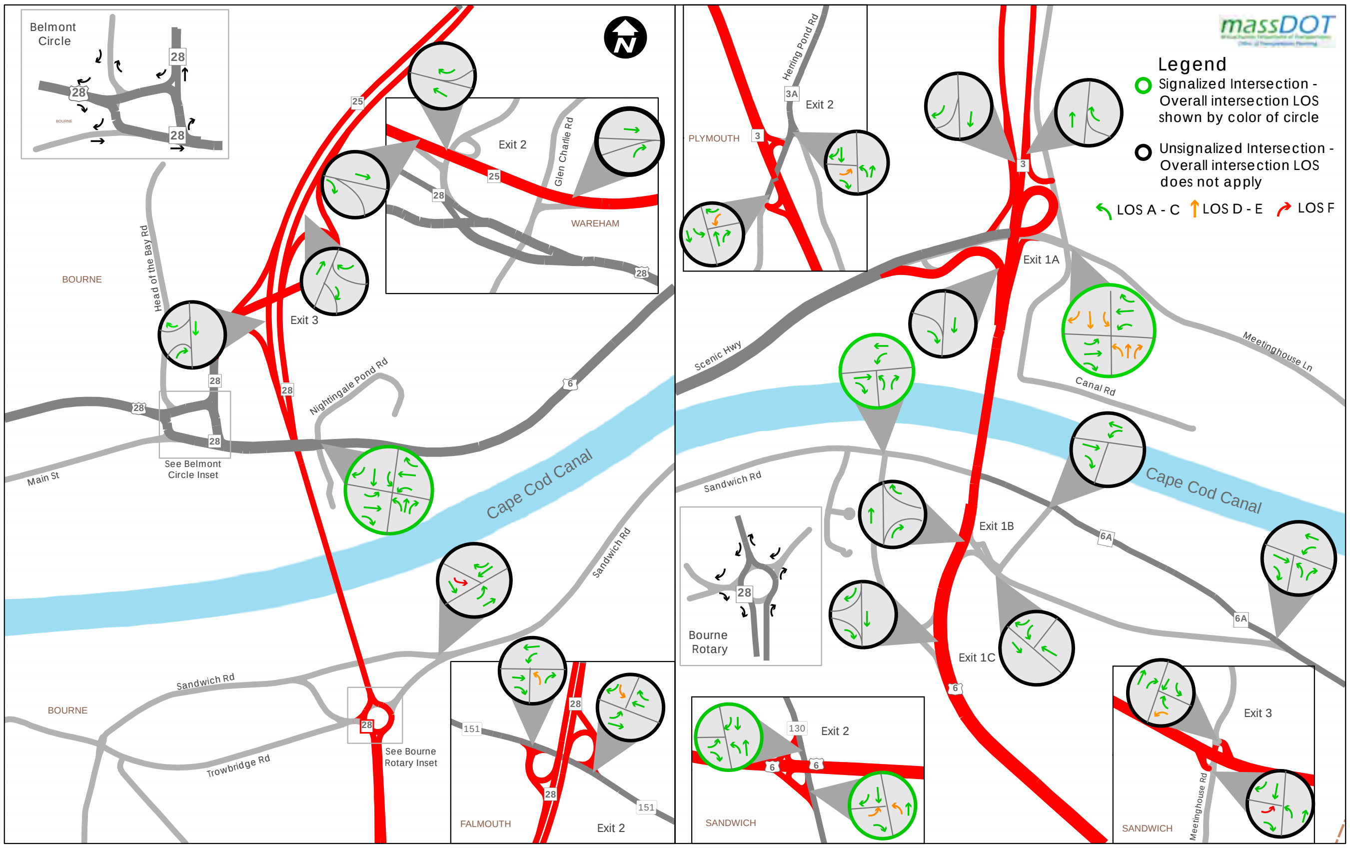
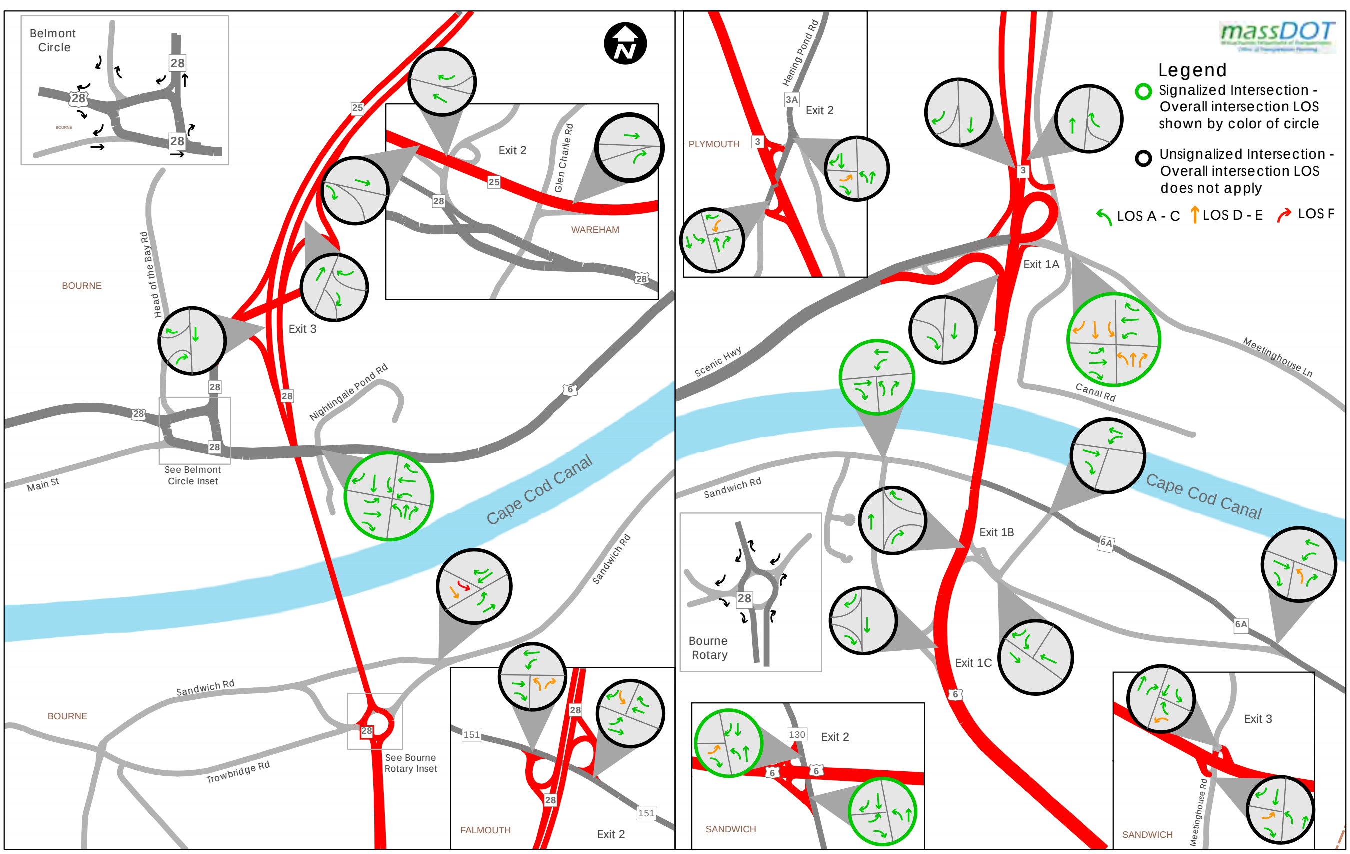



**Exhibit 2-31 Existing Non-Summer Weekday AM Levels of Service (Intersections)**

**Exhibit 2-32 Existing Non-Summer Weekday PM Levels of Service (Intersections)**



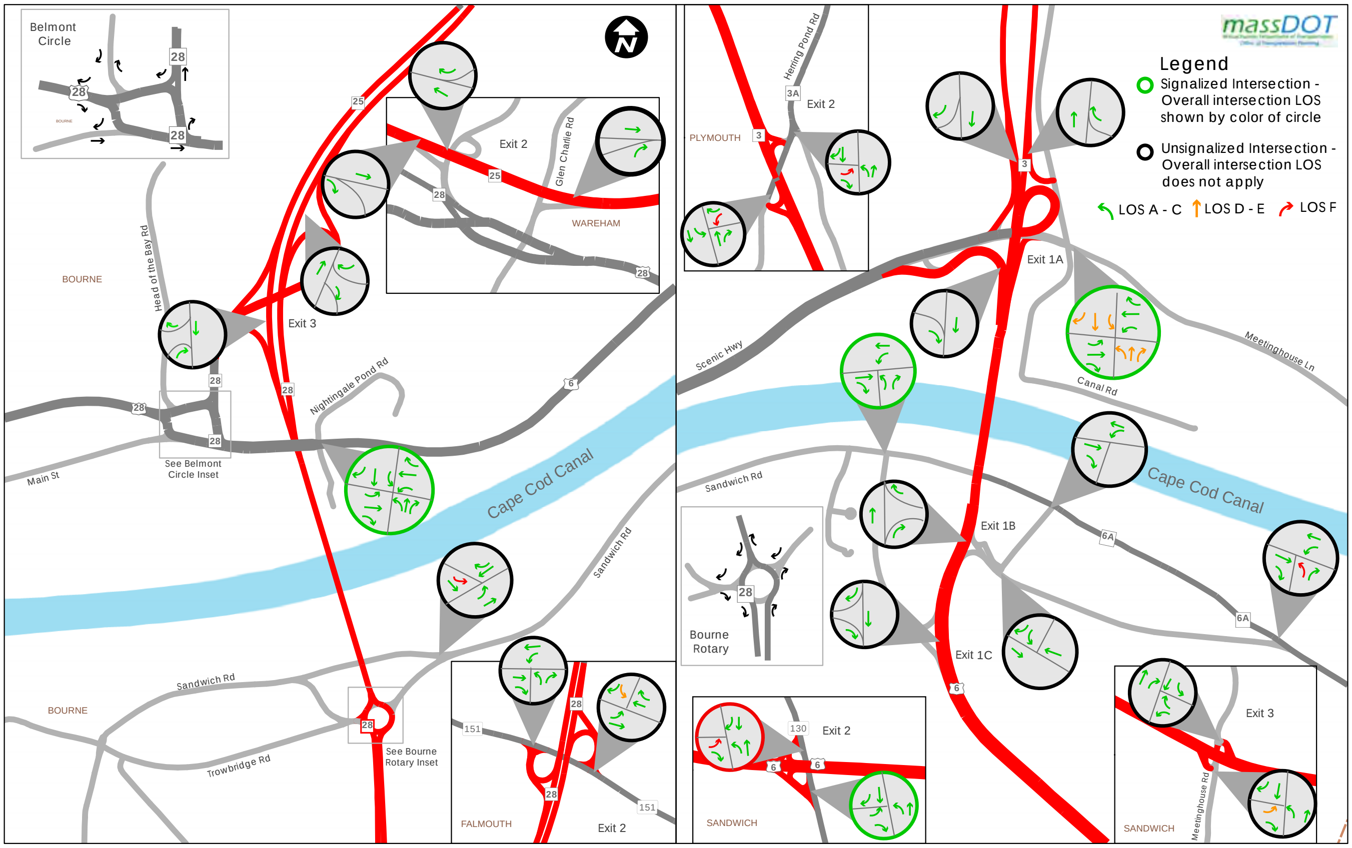
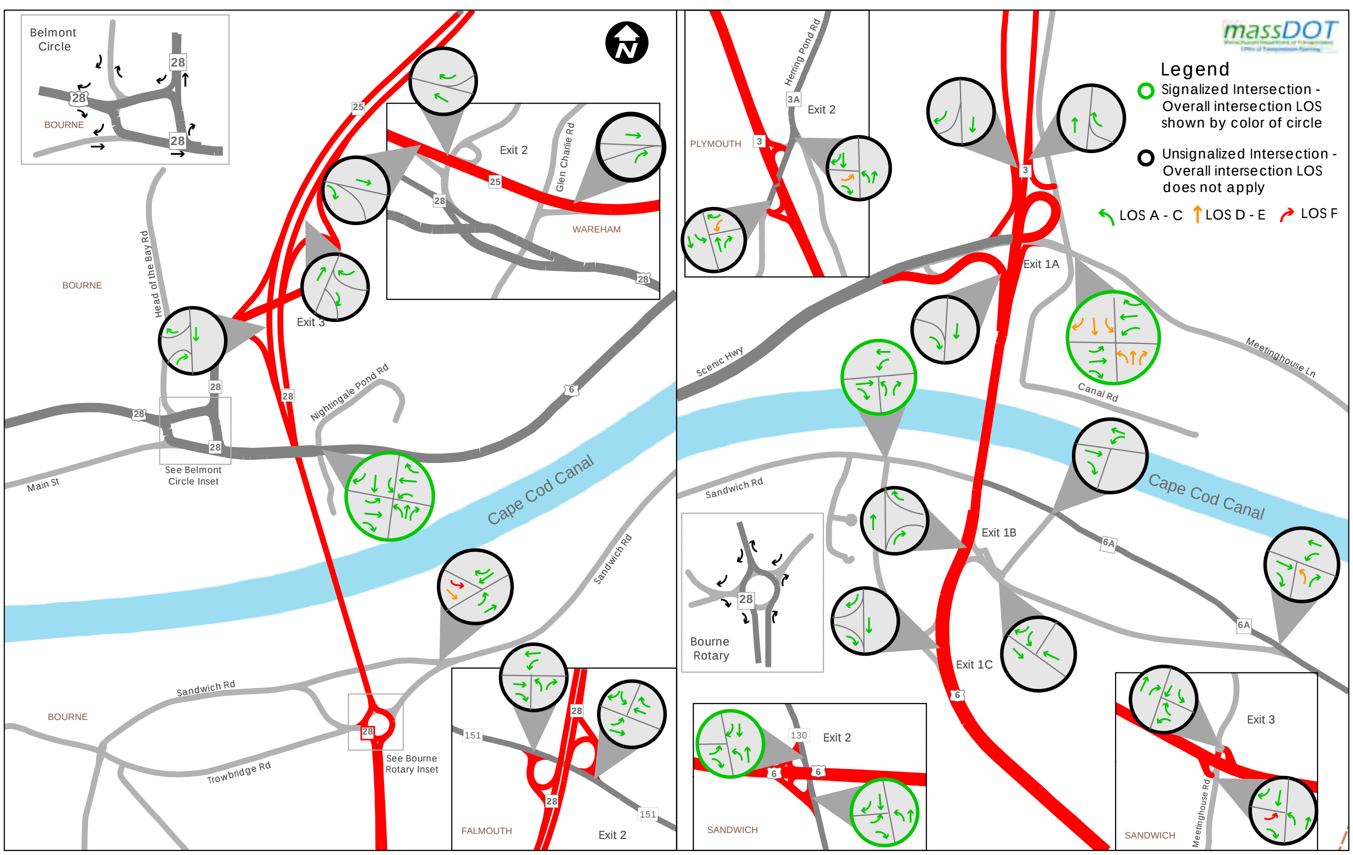
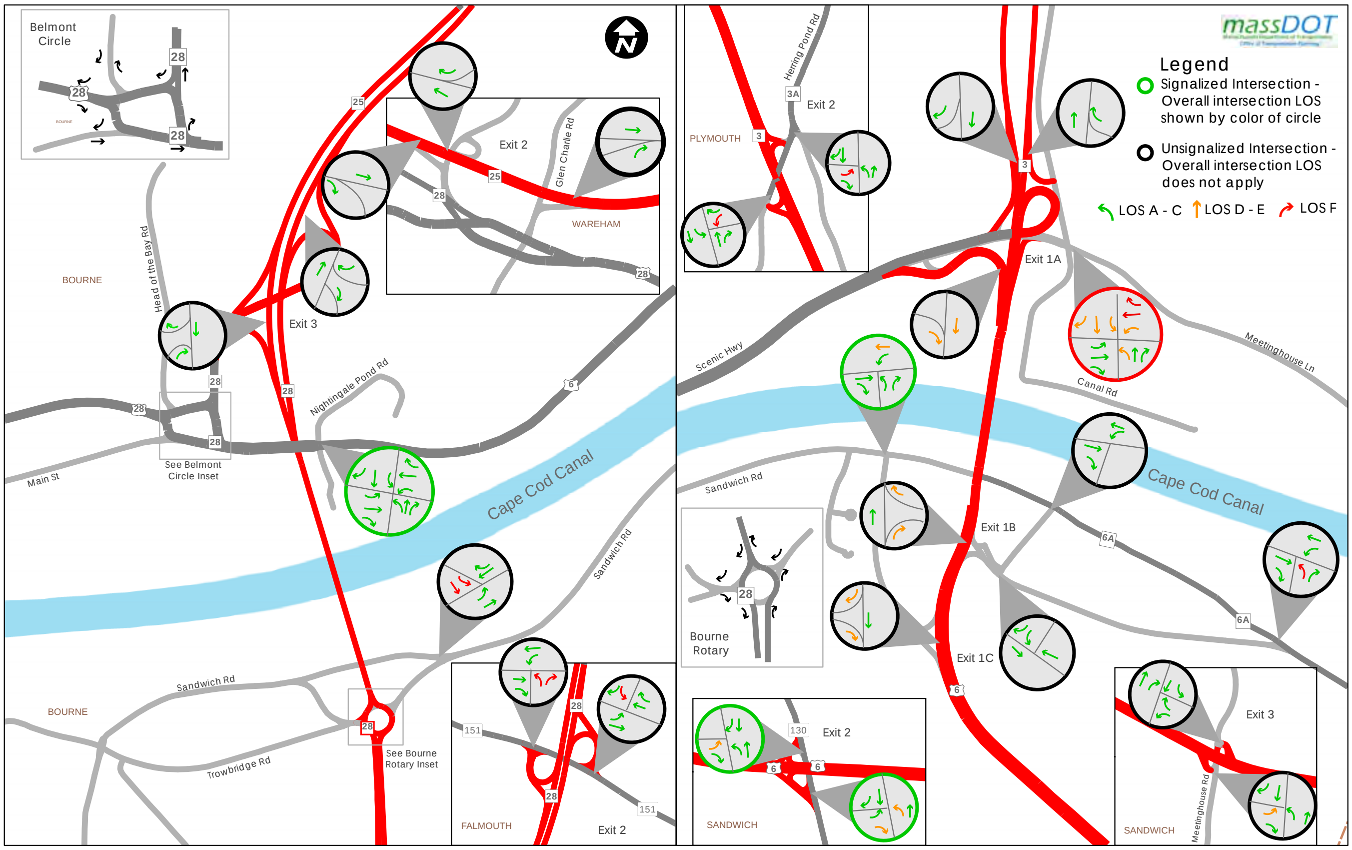



***Exhibit 2-34 Existing Non-Summer Saturday Levels of Service (Intersections)***

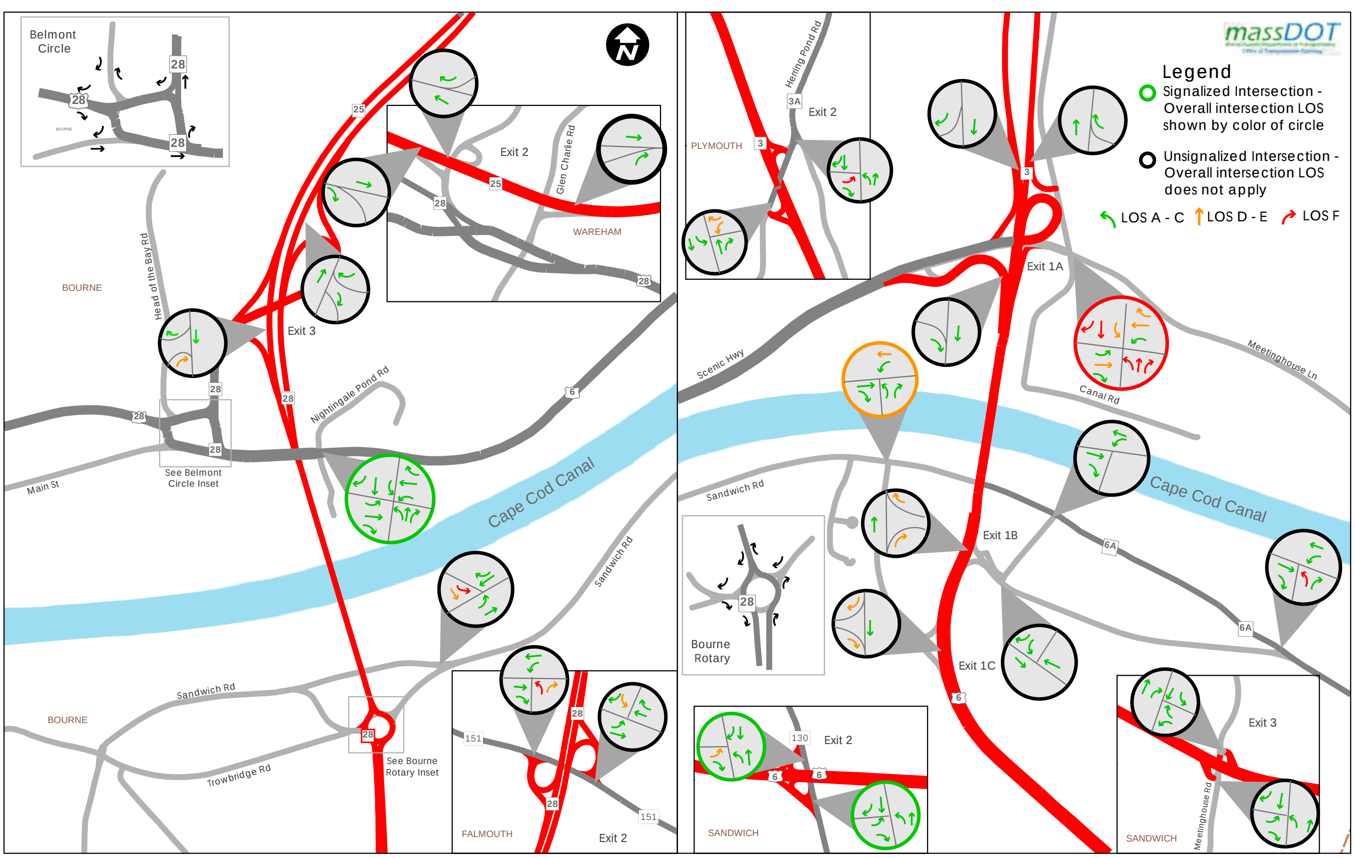
***Exhibit 2-33 Existing Summer Weekday AM Levels of Service (Intersections)***






### Exhibit 2-35 Existing Summer Weekday PM Levels of Service (Intersections)

### Exhibit 2-36 Existing Summer Saturday Levels of Service (Intersections)



The analysis found that most freeway sections operate within a range of LOS A to LOS C during most peak periods. But certain freeway sections experience a lower level of operations (LOS D), especially during summer peak periods, including Route 6 at the Sagamore bridge, Route 6 between Exits 1 and 2, Route 6 at Cranberry Highway, and Route 6 at Route 130. However, as shown on Table 2-18 and Exhibits 2-31 through 2-36 show, far more intersections in the study area operate at an unacceptable LOS E or F during at least one peak hour than operate acceptably.

The most problematic of these locations are intersections that lead directly to the Canal bridges (known as 'gateway intersections') such as Belmont Circle and Bourne Rotary Route 6 Exit 1C is also considered a gateway intersection for this study but is not listed here because, as a highway entrance ramp, it was evaluated for delays and queues, rather than LOS. Other problematic intersections in the study area include Route 130 at Cotuit Road, Herring Pond Road at State Road, and Sandwich Road at its intersections with Adams Street, Bourne Rotary Connector, Technical High School Drive, and Harbor Lights Drive.

### 2.5.9 Origin-Destination Analysis Findings

The traffic data collected in the study area, including data through Automatic Traffic Recorders (ATRs) and Turning Movement Counts (TMCs), is used in conjunction with data from the BlueTOAD™ study to understand the travel patterns within the study area.

A major finding of the BlueTOAD™ origin-destination analysis was the substantial amount of travel between the Route 3/Route 6 corridor and the Route 25/Route 28 corridor. For example, as shown on Exhibit 2-37, during summer Saturdays when visitors are traveling to Cape Cod, 59% of vehicles on Route 25 exit the highway at Belmont Circle and travel east on Scenic Highway to Route 6. Similarly, on summer Sundays when visitors are leaving Cape Cod, 48% of vehicles exit Route 3 at the Sagamore interchange and travel west on Scenic Highway to Route 25, via Belmont Circle. These movements put tremendous pressure on the 'gateway intersections' adjacent to the Canal such as Route 6 Exit 1C, Belmont Circle, and the Bourne Rotary and lead to high levels of congestion during the peak hours.

### 2.5.10 Existing Traffic Conditions at Belmont Circle and Bourne Rotary

Traffic conditions at Belmont Circle and Bourne Rotary were simulated using VISSIM™ software and analyzed using SIDRA™ 5.1 software. As noted in Section 2.5.3, while HCM (Highway Capacity Manual) software was used to determines LOS along highways and intersections in the study area, traffic analysis

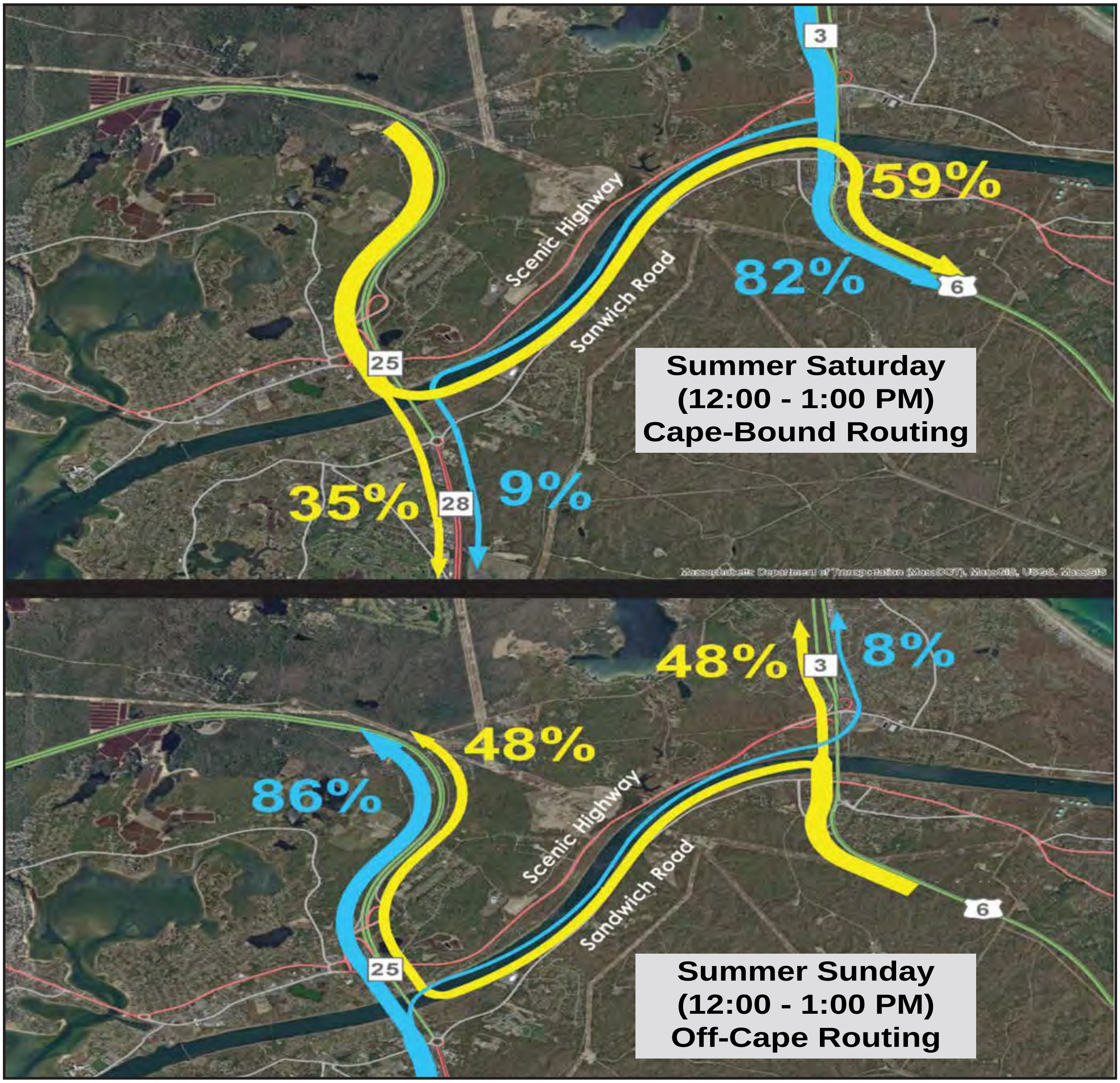



***Exhibit 2-37 Routing of Traffic Between Highway Corridors***

using VISSIM™ and SIDRA™ 5.1 are preferred by MassDOT for the analysis of rotaries, roundabouts, and other unconventional intersections.

Therefore, to understand how traffic operates in Belmont Circle and Bourne Rotary, VISSIM™ software was used to analyze and simulate existing conditions. Traffic conditions within these rotaries are described in terms of the VISSIM™ model's output, including queues, vehicle delays, and travel time. The results from the simulation (average delay) are then used to determine LOS based on the criteria in the HCM.

Belmont Circle and Bourne Rotary, located immediately north and south of the Bourne Bridge, respectively, play a key role in traffic operations in the study area. The high frequency of cross-corridor travel noted in Section 2.5.9 often results in traffic volumes that exceed the capacity of Belmont Circle and Bourne Rotary. This results in significant queues and delays at their approaches.

Further, the proximity of these rotaries to each other can result in queues at one location negatively affecting traffic operations at the other. For example, congestion at the Bourne Rotary often results in queues on Route 28 southbound that extend over the Bourne Bridge beyond the Route 25 southbound entrance ramp from Belmont Circle. This, in turn, can exacerbate traffic congestion at Belmont Circle as vehicles cannot enter Route 25 because of the lengthy queues from Bourne Rotary.

Tables 2-20 and 2-21 and Exhibit 2-38 provide vehicle delay and queue lengths at Belmont Circle and Bourne Rotary, respectively, for the existing (2014) non-summer weekday PM and summer Saturday peak periods.

*Table 2-20 Belmont Circle - Existing (2014) Queue Lengths and Average Delay*

| | AVERAGE VEHICLE DELAY (SEC./MIN.) | | MAX. QUEUE LENGTHS (FEET/MILES) | |
|---|---|---|---|---|
| STREET NAME/APPROACH | NON-SUMMER PM | SUMMER SATURDAY | NON-SUMMER PM | SUMMER SATURDAY |
| Route 25 Exit 3 Off-Ramps (westbound) | 5 | 4 | 515 | 510 |
| Head of Bay Road (southbound) | 15 | 83 (1.4) | 270 | 570) |
| Buzzards Bay Bypass (eastbound) | 3 | 19 | 100 | 335 |
| Main Street (eastbound) | 13 | 82 (1.4) | 530 | 5,755 (1.1) |
| Scenic Highway (westbound) | 7 | 125 (2.1) | 380 | 10,605 (2.0) |

Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.

*Table 2-21 Bourne Rotary - Existing (2014) Queue Lengths and Average Delay*

| | AVERAGE VEHICLE DELAY (SEC./MIN.) | | MAX. QUEUE LENGTHS (FEET/MILES) | |
|---|---|---|---|---|
| STREET NAME/APPROACH | NON-SUMMER PM | SUMMER SATURDAY | NON-SUMMER PM | SUMMER SATURDAY |
| Route 25 (southbound) | 19 | 280 (4.7) | 650 | 8,885 (1.7) |
| Trowbridge Road (eastbound) EB | 75 | 30 | 840 | 335 |
| Route 28 (northbound) | 14 | 301 (5.0) | 340 | 4,135 (0.8) |
| Bourne Rotary Connector (westbound) | 20 | 27 | 1,530 | 1,475 |

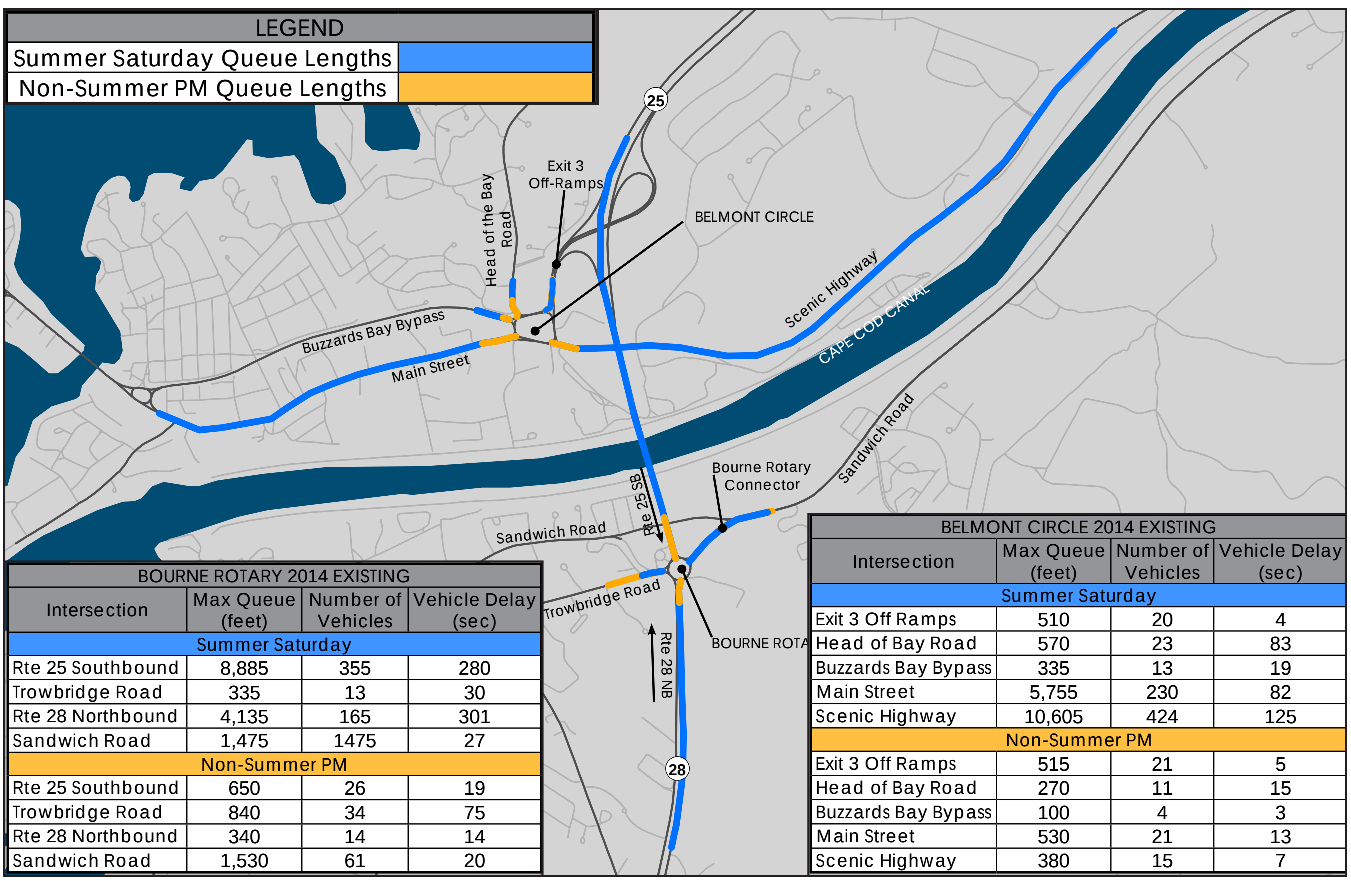
Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.

## *Belmont Circle*

The VISSIM™ analysis quantified average vehicle delays and the maximum queue length for the five approaches to Belmont Circle including Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the Route 25 ramps. As shown on Table 2-20 and Exhibit 2-38, the approaches with the greatest average delay and maximum queue lengths include those from Scenic Highway and the Route 25 ramps to Belmont Circle.

While the average delay during the non-summer weekday are relatively minor (3 to 15 seconds), the average delay during summer Saturday peak periods can extend from 4 to 125 seconds (2.1 minutes). The maximum queues of note include the Main Street (eastbound) approach to Belmont Circle which can extend 530 to 5,755 feet (1.1 miles) during the non-summer weekday and summer Saturday peak hours, respectively. The maximum queues on the Scenic Highway (westbound) approach to Belmont Circle can extend 10,605 feet (2.0 miles) during the summer Saturday peak hour.

***Exhibit 2-38 Belmont Circle and Bourne Rotary Queue Lengths***




| BOURNE ROTARY 2014 EXISTING | | | |
|---|---|---|---|
| Intersection | Max Queue (feet) | Number of Vehicles | Vehicle Delay (sec) |
| Summer Saturday | | | |
| Rte 25 Southbound | 8,885 | 355 | 280 |
| Trowbridge Road | 335 | 13 | 30 |
| Rte 28 Northbound | 4,135 | 165 | 301 |
| Sandwich Road | 1,475 | 1475 | 27 |
| Non-Summer PM | | | |
| Rte 25 Southbound | 650 | 26 | 19 |
| Trowbridge Road | 840 | 34 | 75 |
| Rte 28 Northbound | 340 | 14 | 14 |
| Sandwich Road | 1,530 | 61 | 20 |

| BELMONT CIRCLE 2014 EXISTING | | | |
|---|---|---|---|
| Intersection | Max Queue (feet) | Number of Vehicles | Vehicle Delay (sec) |
| Summer Saturday | | | |
| Exit 3 Off Ramps | 510 | 20 | 4 |
| Head of Bay Road | 570 | 23 | 83 |
| Buzzards Bay Bypass | 335 | 13 | 19 |
| Main Street | 5,755 | 230 | 82 |
| Scenic Highway | 10,605 | 424 | 125 |
| Non-Summer PM | | | |
| Exit 3 Off Ramps | 515 | 21 | 5 |
| Head of Bay Road | 270 | 11 | 15 |
| Buzzards Bay Bypass | 100 | 4 | 3 |
| Main Street | 530 | 21 | 13 |
| Scenic Highway | 380 | 15 | 7 |

### Bourne Rotary

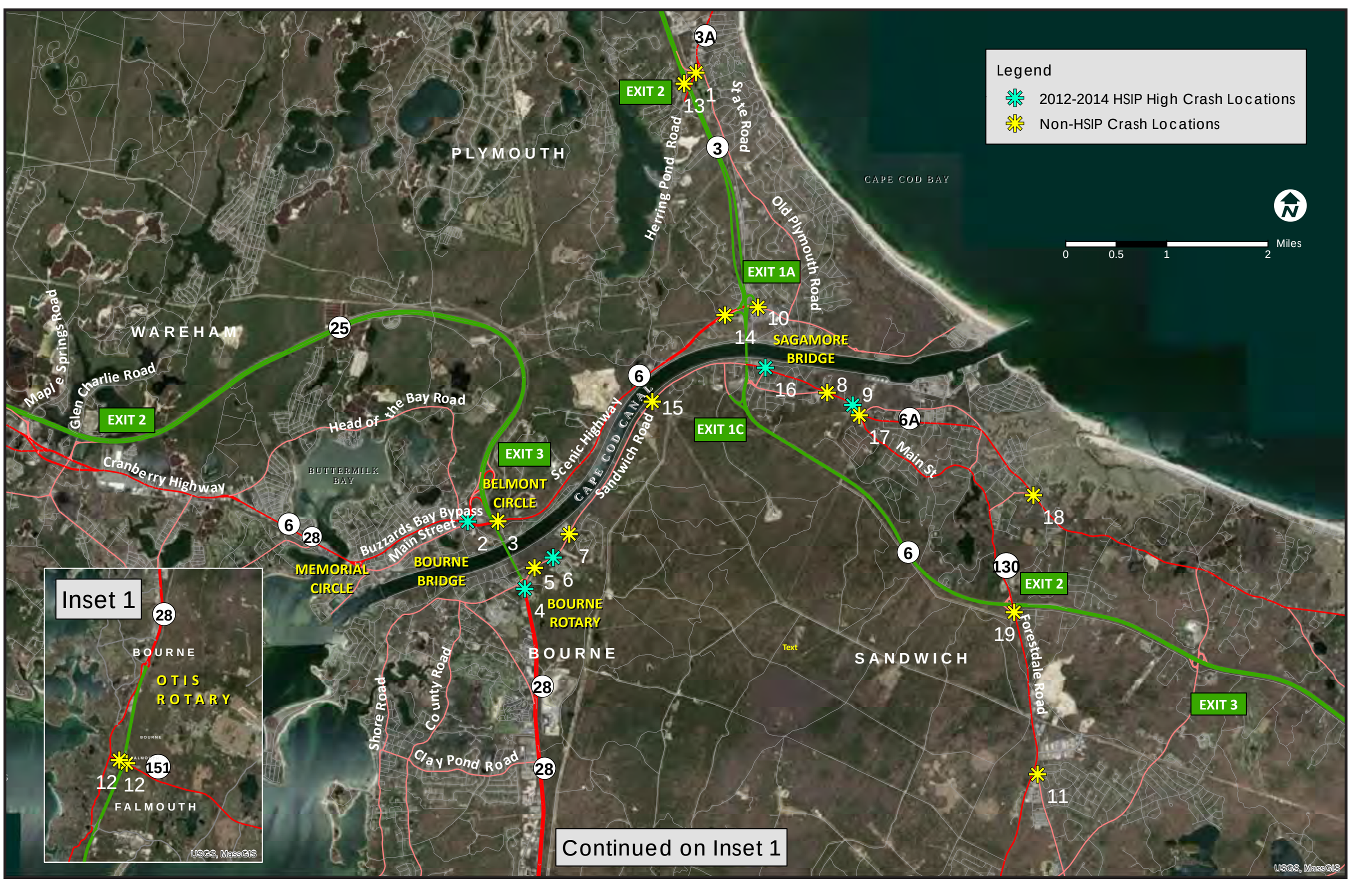
The VISSIM™ analysis quantified average vehicle delays and the maximum queue length for the four approaches to the Bourne Rotary, including Route 28 (north and south end), Trowbridge Road, and Sandwich Road. As shown on Table 2-21 and Exhibit 2-38, the approaches with the greatest average delay and maximum queue lengths include those from Route 28 southbound and Route 28 northbound.

While the average delay during the non-summer weekdays are modest (14 to 75 seconds), the average delay during summer Saturdays can extend from 27 to 301 seconds (5.0 minutes). The queues of note include the Route 25 (southbound) approach to the Bourne Rotary which can extend 650 to 8,885 feet (1.7 miles) during the non-summer weekday PM and summer Saturday peak hours, respectively. The queues on the Route 28 (northbound) approach to Bourne Rotary can extend 340 to 4,135 feet (0.8 miles) during the non-summer weekday PM and summer Saturday peak periods, respectively.

## 2.5.11 Crashes

Crash data was collected for the years 2012-2014 (the most recent three-year period available at the time data was collected)

***Exhibit 2-39 Crashes in the Study Area***



from all study area intersections analyzed for LOS. These data were used to create diagrams that portray crashes by type and by frequency (provided in Appendix D). Analysis of these diagrams—that is, the types of crashes and where they took place—helped the study team understand why crashes may be occurring at certain locations. Table 2-22 summarizes crash data for the study area. Exhibit 2-39 shows the location crashes in the study area.

Crash rates were calculated for each study area intersection and compared to the average crash rate for MassDOT' s District 5, which includes Cape Cod and Southeastern Massachusetts.

*Table 2-22 Crashes in Study Area, 2012–2014*

| TOWN | NAME OF LOCATION | MAP NUMBER | HSIP LOCATION[1] (Y/N) | 2012 | 2013 | 2014 | TOTAL (2012-2014) | EPDO[2] | CRASH RATE[3] |
|---|---|---|---|---|---|---|---|---|---|
| Plymouth | Herring Pond Road at State Road | 1 | N | 5 | 3 | 13 | 9 | 13 | **0.42** |
| Plymouth | Route 3 SB Exit 2 Off/On Ramps at Herring Pond Rd | 13 | N | 1 | 3 | 4 | 8 | 12 | **0.52** |
| Bourne | Belmont Circle | 2 | Y | 26 | 29 | 32 | 87 | 127 | **1.40** |
| Bourne | Scenic Highway at Nightingale Pond Road/Olivia Drive | 3 | N | 11 | 9 | 3 | 23 | 27 | 0.61 |
| Bourne | Scenic Highway at Church Lane | 14 | N | 2 | 2 | 1 | 5 | 9 | 0.16 |
| Bourne | Scenic Highway/Meetinghouse Lane at State Road | 10 | N | 4 | 8 | 7 | 19 | 25 | **0.82** |
| Bourne | Bourne Rotary | 4 | Y | 31 | 38 | 45 | 114 | 150 | **2.12** |
| Bourne | Sandwich Road at Bourne Rotary Connector | 5 | N | 5 | 3 | 1 | 9 | 15 | 0.25 |
| Bourne | Sandwich Road at High School Drive | 6 | Y | 3 | 1 | 3 | 7 | 9 | 0.27 |
| Bourne | Sandwich Road at Harbor Lights Road | 7 | N | 0 | 1 | 0 | 1 | 3 | 0.04 |
| Bourne | Sandwich Road at Jarvis Drive | 15 | N | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Bourne | Sandwich Road at Adams Street[4] | 16 | Y | 8 | 10 | 11 | 29 | 42 | **1.66** |
| Bourne | Sandwich Road at Cranberry Highway/Regency | 8 | N | 3 | 7 | 2 | 12 | 26 | **0.58** |
| Sandwich | Route 130 (Main Street)/Route 6A/ Tupper Road | 9 | Y | 6 | 3 | 3 | 12 | 24 | 0.59 |
| Sandwich | Route 6A at Main Street | 17 | N | 0 | 0 | 1 | 1 | 3 | 1.02 |
| Sandwich | Old Kings Highway at Main Street | 18 | N | 1 | 1 | 0 | 2 | 4 | 0.16 |
| Sandwich | Route 6 Eastbound (Exit 2) Ramps at Route 130 | 19 | N | 0 | 2 | 3 | 5 | 9 | **0.20** |
| Sandwich | Route 130 at Cotuit Road | 11 | N | 6 | 1 | 1 | 8 | 18 | **0.34** |
| Falmouth | Route 28 Southbound Off/On Ramps at Route 151 | 12 | N | 3 | 4 | 2 | 9 | 15 | **0.34** |
| Falmouth | Route 28 Northbound Off/On Ramps at Route 151 | 12 | N | 5 | 3 | 2 | 10 | 22 | **0.34** |

[1] Highway Safety Improvement Program (HSIP) – Crash cluster in which the total number of 'equivalent property damage only' crashes in the cluster are within the top 5% of all clusters in that region.
[2] Equivalent Property Damage Only (EPDO) – crash analysis method that weights factors related to the societal costs of fatal, injury, or property damage-only crashes.
[3] **Bold** text indicates accident rate exceeds District 5 average crash of 0.76 and 0.58 per million entering vehicles for signalized and unsignalized intersections, respectively.
[4] Adams Street converted to one-way (southbound) travel only in 2015.

District 5 had an average crash rate of 0.76 crashes (signalized intersections) and 0.58 crashes (unsignalized intersections) for every million vehicles who traveled through the intersection.[5]

Eight locations within the study area rank as high-crash locations under the Highway Safety Improvement Program (HSIP). This MassDOT designation identifies crash clusters that rank within the top five percent of their respective regional planning agency's crash locations. This criterion reflects a combination of factors, including crash incidence and severity, based on an equivalent property damage only (EPDO) index that assigns points based on the type of accident. Property-damage-only crashes earn 1 point on this scale; injury crashes earn 5 points; and fatal crashes earn 10 points.

The locations in the study area with the highest crash rates include Belmont Circle, Bourne Rotary, and the intersections of Route 6A at Route 130 and Scenic Highway at Meetinghouse Lane.

## 2.6 MULTIMODAL TRANSPORTATION

This section describes other modes of transportation used by people in the study area, including walking, bicycling, buses, trains, ferries, and airplanes. These other transportation modes provide safe ways to travel and encourage healthy non motorized travel. These facilities function as critical transportation modes for non drivers.

The varied elements of a multimodal transportation system work best when they work together. For example, one may bike to a transit facility to catch a bus to work or drive to a downtown area then walk to various shops.

This section provides details on these transportation modes and gaps identified in connecting these transportation modes.

### 2.6.1 Pedestrian Facilities

Pedestrian facilities in the focus area include sidewalks and recreational trails. Sidewalks are generally present in more densely developed residential and commercial areas but absent elsewhere (Exhibit 2-40). Many roads in the study area are narrow (20-22 feet) and lack sidewalks, presenting difficulties for pedestrians, particularly the elderly or those with disabilities. Sidewalks are especially important along bus routes to allow people to walk safely to/from bus stops. Sidewalks along major travel corridors in the focus area include those along the southern side of Scenic Highway from Nightingale Road

5 Known as 'crashes per million entering vehicles' (PMEV)

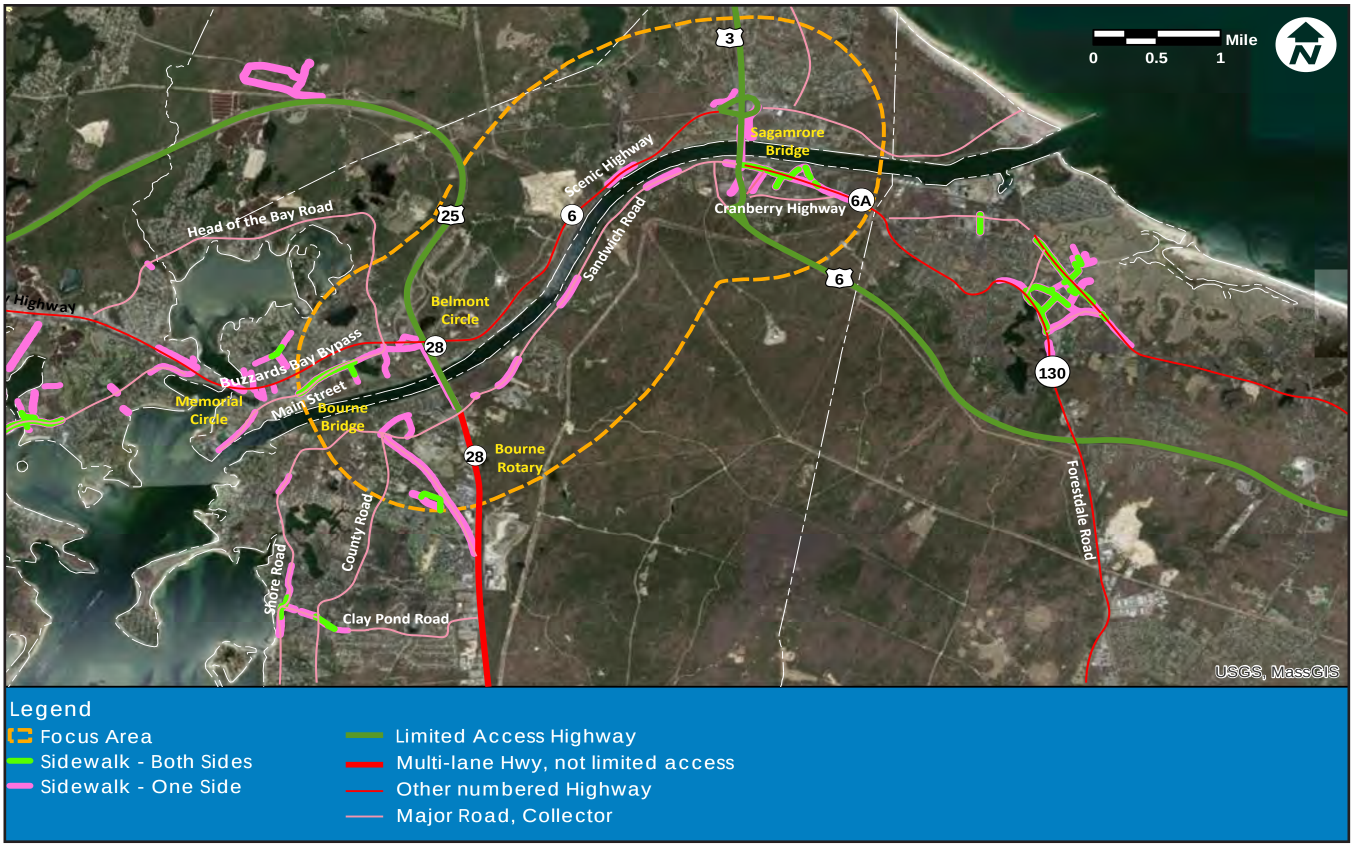



***Exhibit 2-40 Pedestrian Facilities in the Focus Area***

west along the southern edge of Belmont Circle and continuing through the Main Street business district in Bourne.

Sidewalks also exist on Trowbridge Road and the southern side of Sandwich Road from the Mid-Cape Connector to Route 6A and continuing along either one or both sides of Route 6A to Tory Lane. After a 1.5-mile gap, sidewalks continue Route 6A for 1.25 miles from Tupper Road (east end) to Crowell Lane. Both the Sagamore and Bourne bridges provide a single, narrow sidewalk, but several of the approach roadways to the bridges lack accessible sidewalk connections. For example, pedestrians can only reach the Bourne Bridge sidewalk from the north on an unmarked sidewalk at the end of the Bridge approach via the end of a shopping area entrance drive. To reach the sidewalk at the south end of the Bourne Bridge, a pedestrian would need to enter the Bourne Rotary, a high-volume traffic circle that lacks sidewalks.

For safety reasons, limited-access highways, including those in the study area such as Route 6, Route 3, and Route 25, prohibit pedestrian access and do not have sidewalks. Other roadways in the study area—such as Route 28, Route 151, Buzzards Bay Bypass, Sandwich Road, Tupper Road, Shore Road, County Road, and Scenic Highway (except in the immediate area of the Route 3 interchange)—also generally lack sidewalks.

Counts of pedestrians and bicyclists were conducted at intersections throughout the study area. Table 2-23 presents these counts the results of these counts for the non-summer weekday and summer Saturday peak periods. Higher pedestrian and bicycle activity occur in areas containing a greater concentration of retail or commercial establishments or near residential neighborhoods and schools. These areas include Route 6A in Sandwich and Trowbridge Road and Main Street in Bourne.

Gaps exist in the connections for pedestrian and bicycle access across the Canal and between the Cape Cod Canal service road (bike path) and local roadways in the study area. Exhibit 2-41 displays the desire route for pedestrians and bicyclists over the Canal at both the Bourne and Sagamore Bridges. At the approaches to both bridges gaps exists in the sidewalk system to allow pedestrians or bicyclists to cross the Canal. Sidewalks do not exist that would connect the south end of Sagamore Bridge to either Cranberry Highway or Sandwich Road. At the north end of the Bourne Bridge, lack of sidewalks limit pedestrian access to Belmont Circle.

While scattered pedestrian/bicycle connections exist between the Cape Cod Canal service road (bike path) and local roadways in the

*Table 2-23 Pedestrian and Bicycle Counts at Select Intersections*

| INTERSECTION | BICYCLES | | | | | | PEDESTRIANS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SUMMER | | | NON-SUMMER | | | SUMMER | | | NON-SUMMER | | |
| | AM | PM | SAT | AM | PM | SAT | AM | PM | SAT | AM | PM | SAT |
| Route 130 at Route 6 EB On-Off Ramps | 2 | 6 | 17 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Route 6A at Route 130 and Tupper Road | 0 | 7 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 1 | 1 |
| Route 6A at Main Street | 7 | 8 | 24 | 0 | 0 | 1 | 8 | 9 | 5 | 7 | 0 | 3 |
| Cranberry Highway at Sandwich Road and Regency Road | 1 | 3 | 11 | 0 | 0 | 1 | 1 | 7 | 9 | 3 | 4 | 2 |
| Sandwich Road at Adams Street | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 3 |
| Route 130 at Cotuit Road | 1 | 6 | 11 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| Route 6 at Quaker Meetinghouse Road | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| Bourne Rotary | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 1 |
| Trowbridge Road at Veterans Way | 4 | 3 | 7 | 0 | 0 | 0 | 12 | 1 | 4 | 0 | 1 | 2 |
| Trowbridge Road at Sandwich Road and County Road | 5 | 2 | 25 | 0 | 0 | 5 | 0 | 2 | 0 | 0 | 0 | 6 |
| Route 6 (Scenic Highway) at Nightingale Pond Road | 2 | 2 | 3 | 0 | 1 | 0 | 0 | 22 | 8 | 0 | 0 | 0 |
| Memorial Circle | 2 | 5 | 25 | 0 | 2 | 11 | 1 | 2 | 3 | 0 | 1 | 0 |
| Meetinghouse Lane at Canal St. | 0 | 3 | 6 | 0 | 0 | 0 | 5 | 1 | 1 | 3 | 1 | 8 |
| Tupper Road at Old King's Highway (Route 6A) | 5 | 11 | 17 | 0 | 0 | 0 | 6 | 9 | 15 | 0 | 0 | 8 |
| State Road at Route 3 NB Ramp and Homestead Road | 0 | 0 | 7 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 |
| Route 151 at Route 28 SB On-Off Ramps | 5 | 4 | 17 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Route 151 at Route 28 NB On-Off Ramps | 5 | 3 | 14 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Herring Pond Road at Route 3 NB On-Off Ramps | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 5 | 13 | 0 | 0 | 0 |

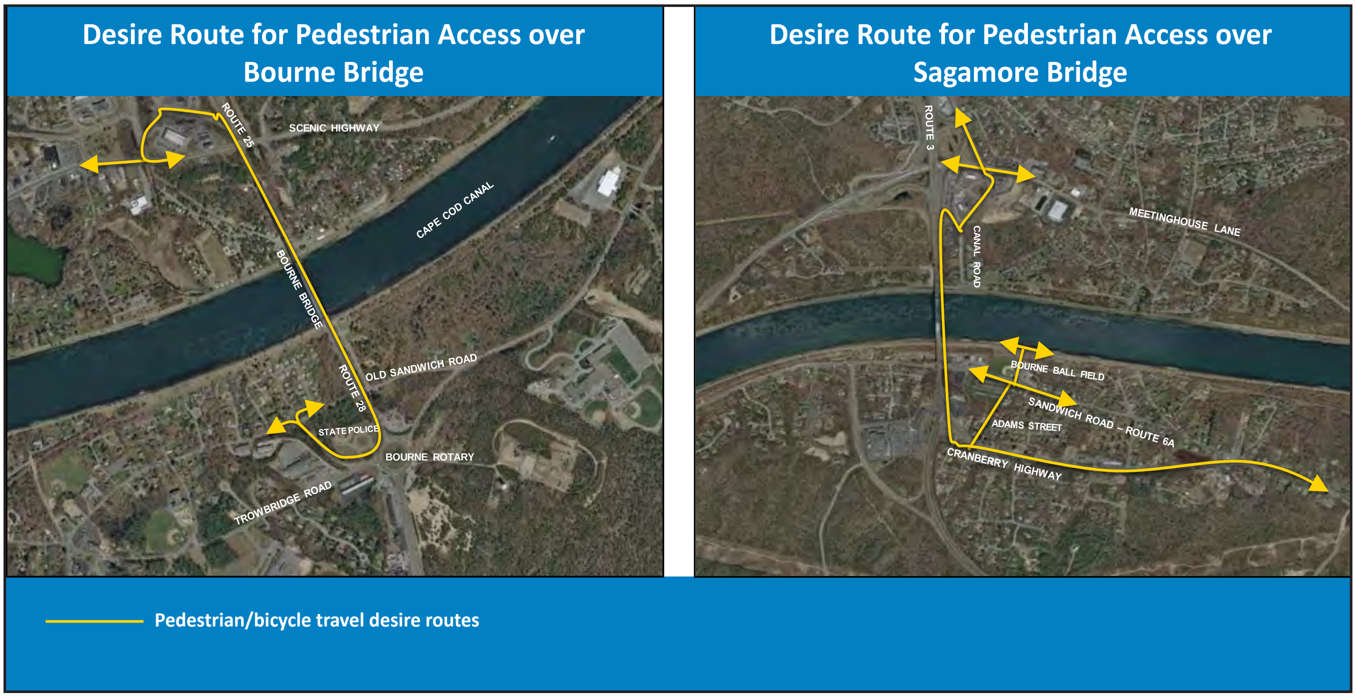



***Exhibit 2-41 Pedestrian/Bicycle Travel Desire Routes over the Canal Bridges***

focus area, there are notable gaps. Existing connections north of the Canal include Old Bridge Road, Herring River Recreation Center, Sagamore Recreation Area, Old Plymouth Road, and several along Scusset Beach Road. South of the Canal pedestrian connections to the Canal bike path include those at the Sandwich Marina Park, Sandwich Road, Bourne Recreation Area, and the Railroad Bridge Access parking lot. As shown on Exhibit 2-42, gaps in these connections exists west of the Bourne Bridge and east of the Sagamore Bridge.

### 2.6.2 Bicycle Facilities

Bicycle facilities in the study area include the Cape Cod Canal service roads (bike paths), owned and maintained by the U.S. Army Corps of Engineers. The service roads run on both the north and south sides of the Canal, and each is about 7 miles long. The service roads are very popular local resource for bicycle recreation and commuting. A daily count conducted by the Cape Cod Commission during July 2017 found 827 bicyclists using the Canal service road.

Lighting, benches and seating areas are provided along the path on both sides of the service road. While there are several accessible connections to the service roads from the local roadway network or parking lots, there are also notable areas that lack an accessible, ADA[6]-compliant connection to the service road.

6 Americans with Disabilities Act of 1990.

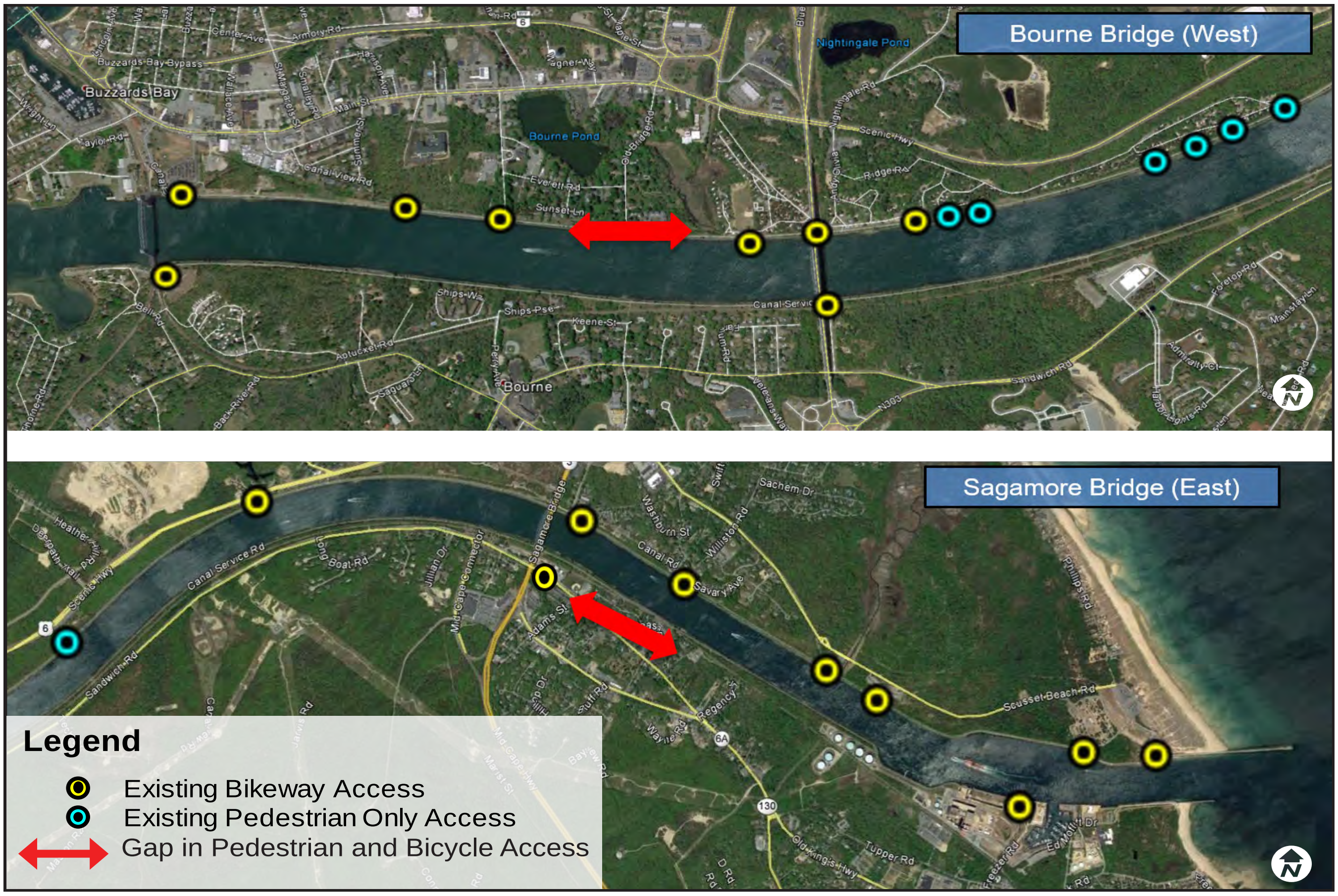



*Exhibit 2-42 Gaps in Pedestrian/Bicycle Connections to Canal Bike Path*

While somewhat outside of the study area, the Shining Sea Bike Path extends 10.6 miles from the Steamship Authority terminal in Woods Hole to County Road (Route 151) in Falmouth. An on-road bike route is designated on Route 6A in Sandwich.

Exhibit 2-43 shows the proximity of bicycle path and on-road bicycle routes to bus routes. Services provided by area transit organizations enhance bicycle access in the study area. The Cape Cod Regional Transit Authority (CCRTA) buses have racks for two bicycles, and the Steamship Authority (SSA) ferry service allows passengers to pay to take bicycles on the ferries.

Gaps between bicycle facilities and bus routes exist between the Canal service road (bike path) and the bus routes that cross the Canal bridges. Gaps also exist between the northern limit of the off-road Shining Sea bike path in Falmouth and bus routes along County Road and Shore Road in Bourne.

### 2.6.3 Transit Services

Cape Cod's unique shape allows access from multiple directions through a wide range of modes. For ground transportation, bus

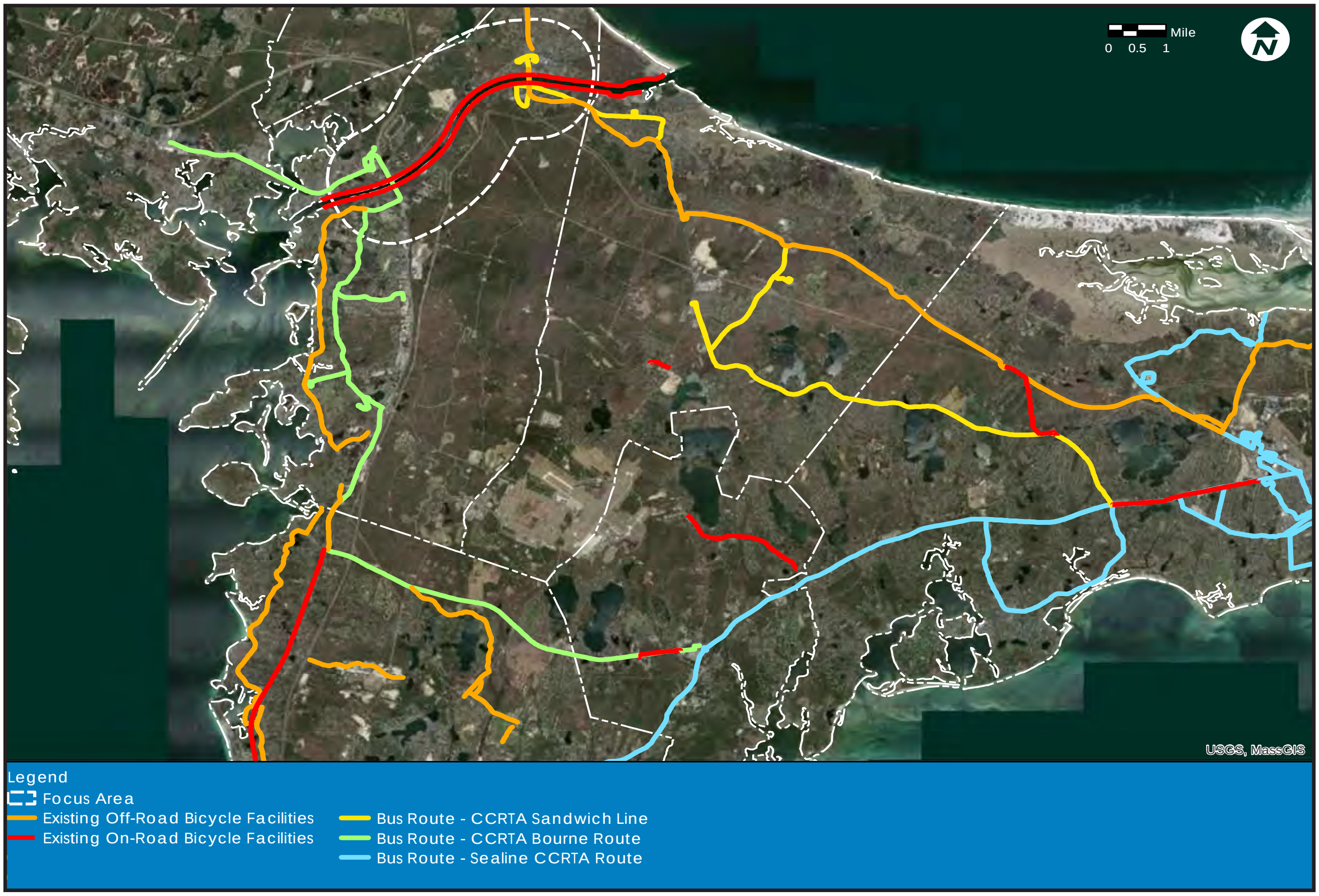



***Exhibit 2-43 Bicycle Facilities and Bus Routes in the Study Area***


*CCRTA Map*

and train service connect to places as far as Boston and New York City. Over water, ferry service connects the Cape to Nantucket, Martha's Vineyard, and Boston. Two municipal airports offer direct flights to Martha's Vineyard, Nantucket, Boston, New York City, and Washington D.C.

Multimodal transportation on Cape Cod centers on the Hyannis Transportation Center, built in 2002. The Center serves as a terminal for local and long-distance bus service and as a rail station for the seasonal MBTA Cape Flyer. The Center provides parking for 220 vehicles, and it has entrances from Route 28, Center Street, and Ridgewood Avenue in Hyannis. Proximity to Barnstable Municipal Airport and the Hyannis Ferry Dock (both less than one mile away) allows for quick transfers between transportation modes.

### 2.6.4 Bus Service

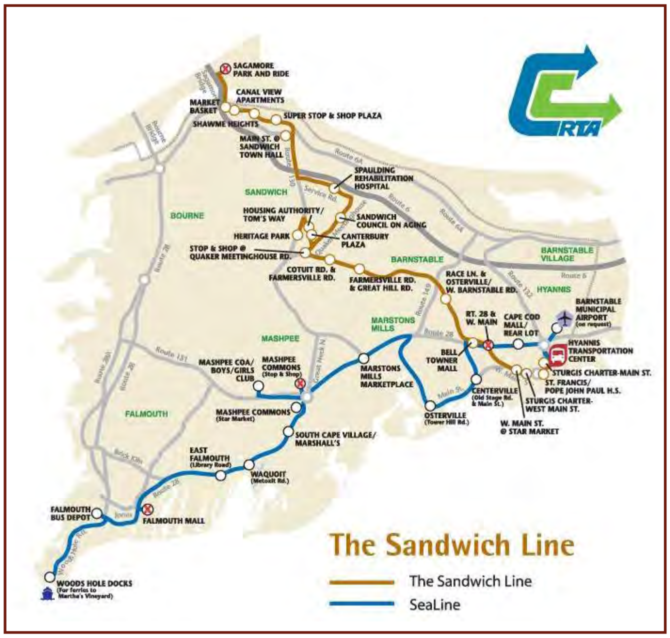
This section summarizes Cape Cod bus services. The Cape Cod Regional Transit Authority (CCRTA) serves as the primary transit provider within the study area. Other bus companies serving the area include the Greater Attleboro Taunton Regional Transit Authority (GATRA), Peter Pan Bus Company, and the Plymouth & Brockton Bus Company.

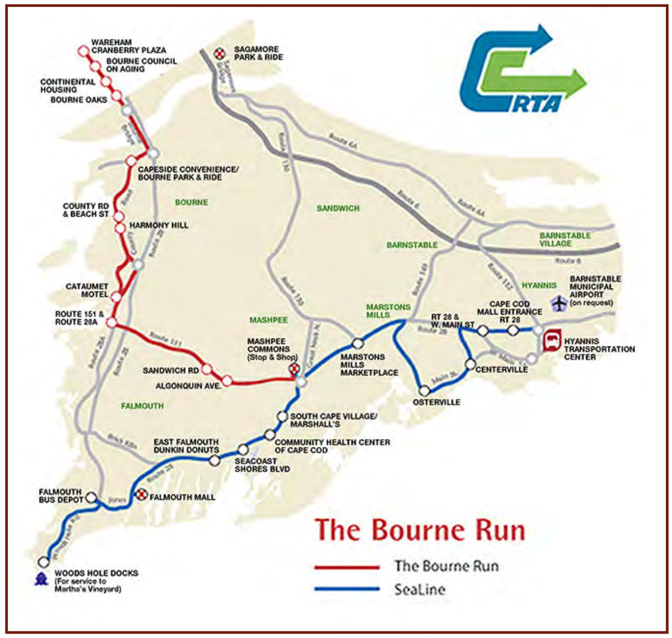
#### *Cape Cod Regional Transit Authority (CCRTA)*

A public transit authority, CCRTA provides bus service daily during the summer and weekdays and Saturdays during the off-season. Schedules and some stops also vary seasonally. The routes have designated stops, and passengers can request some stops on board. As described below, CCRTA operates six year-round fixed-route services covering every town on Cape Cod. These include the SeaLine, H2O Hyannis-Orleans (H2O Line), FLEX, Barnstable Villager, Sandwich Line and Bourne Run. Seasonal fixed-route services include the WOOSH Trolley, The Hyannis Area Trolley and the Provincetown/North Truro Shuttle. Access to these transit services is often limited by the lack of accessible sidewalks and bus shelters along CCRTA bus stops in the study area, particularly along Shore Road, County Road, and Route 6A.

#### *CCRTA Fixed Routes*

The SeaLine route runs from the Woods Hole docks in Falmouth to the Barnstable Municipal Airport with stops including the Hyannis Transportation Center. The SeaLine travels along Route 28 and deviates to Osterville and Centerville centers. Along Route 28, the SeaLine travels to Mashpee Commons, Falmouth Center, the Falmouth bus depot, and Woods Hole.




*CCRTA Route Maps:*
*The Sandwich Line, left*
*The Bourne Run, right*

The H2O line runs from the Hyannis Transportation Center to the Stop & Shop in Orleans. The bus travels to the Cape Cod Hospital and along Route 28 to the Stop & Shop and Star Market in Yarmouth, the Dennis Shopping Area, the Stop & Shop and Patriot Square in Dennis, the Harwich Chamber of Commerce, through Chatham and to the CVS and Stop & Shop in Orleans. From the H2O line, riders can connect to the FLEX bus that continues to Provincetown. The line also connects at the Hyannis Transportation Center with the SeaLine, the Barnstable Villager, intercity buses and in summer, with the Hyannis Trolley.

The FLEX travels from Route 28 in Harwich, over Queen Anne to Route 137, to Brewster on Route 6A, down Route 6 through the towns of Orleans, Eastham, Wellfleet, and Truro to Provincetown. The FLEX picks up and drops passengers off at designated stops and will deviate off its route for up to 0.75 miles. The FLEX line also offers transfer connections to the H2O line at various points in the towns of Harwich and Orleans.

The Barnstable Villager runs from downtown Hyannis at the Hyannis Transportation Center to the Courthouse Complex in Barnstable Village. The route passes through neighborhoods in the north and south of the Mid-Cape area. During the summer season, the route also serves Barnstable and Hyannis harbors. Passengers make connections to the H2O and SeaLine at the Hyannis Transportation Center.

The Bourne Run travels from the Walmart at Cranberry Plaza in Wareham through Bourne and Falmouth to Mashpee Commons. As shown below, the Bourne Run travels across the Bourne Bridge, through downtown Buzzards Bay, and along Routes 28A and 151 in Bourne, Falmouth and Mashpee. The Bourne

Run offers the only connection to Greater Attleboro Taunton Regional Transit Authority and the Onset/Wareham Link (OWL) fixed-route systems.

The Sandwich Line travels from the Sagamore Park and Ride across the Sagamore Bridge to the Hyannis Transportation Center through Sandwich (see figure on previous page). It passes through historical downtown Sandwich on Route 6A, travels on Race lane in Barnstable and then connects through Route 28 to Hyannis. This route offers transfer connections to the SeaLine, H2O and Barnstable Villager at the Hyannis Transportation Center.

The CCRTA's newest route, the Hyannis Loop, travels from the Hyannis Transportation Center to the Cape Cod Mall, Southwind Plaza, Festival mall, and other downtown locations. It connects the Hyannis Transportation Center with several other CCRTA fixed route services: the SeaLine, Villager, Sandwich Line, and H2O line. It also connects with Plymouth & Brockton and Peter Pan bus services. The Hyannis Loop travels from the Hyannis Transportation Center down Main Street, North Street, and West Main Street to Route 28 then connects to the Festival Mall and Super Stop & Shop via Pitchers Way. It then follows Attucks Lane to Independence Drive before following Route 28 and Barnstable Road back to the Hyannis Transportation Center.

### *CCRTA Seasonal Fixed Routes*

Within Hyannis, Provincetown, and Falmouth, CCRTA runs seasonal trolleys to and from the ferry docks to help meet the demand for increased transit service from May through September. All trolleys run every hour or half-hour for ten or more hours a day.

In Hyannis, the Hyannis Area Trolley (HAT) operates seven days a week, from late June through Labor Day, including holidays. The HAT runs from the Hyannis Transportation Center to the Steamship Authority ferry docks and the Cape Cod Hospital before coming back to the Hyannis Transportation Center. The HAT route includes stops at the JFK Museum, Kennedy Memorial and Veterans Beach.

In Provincetown, CCRTA runs two shuttles. One route travels between MacMillan Pier in Provincetown to the National Park Service's Province Land Visitors Center, Race Point Beach, and the Provincetown Municipal Airport. The other route travels from MacMillan Pier to Beach Point in Provincetown to the North Truro and Horton's Campgrounds.

In Falmouth, the WHOOSH Trolley runs late June through early September daily from the Falmouth Mall to the Steamship

Authority docks. This line connects to the SeaLine fixed route service at the Falmouth bus depot, Falmouth Mall, and the Steamship Authority in Woods Hole.

### Demand Response

CCRTA also provides demand-response services: Dial-A-Ride Transportation (DART); Americans with Disabilities Act (ADA) paratransit services, and Boston Hospital Transportation.

DART service, which operates as a door-to-door ride by appointment, is available to the public, with priority given to seniors and individuals with disabilities. DART service is available Monday through Saturday in all 15 Barnstable County towns, with limited service on Sunday. Vehicles used for DART services include 10- to 12-person vans and/or 15- to 18-person mini buses.

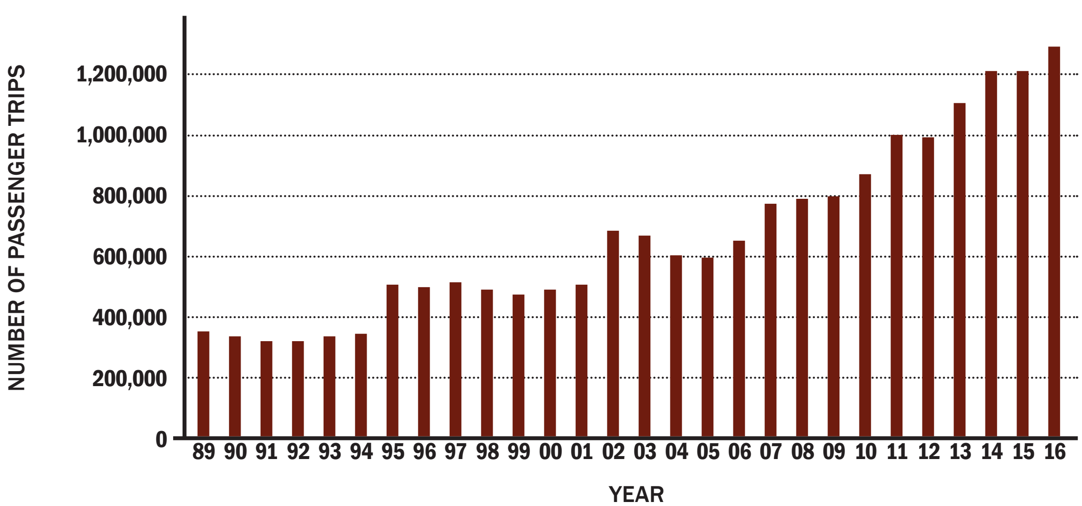
ADA Paratransit is a door-to-door shared-ride service for passengers who meet ADA eligibility requirements established by law in 1990. ADA Paratransit vehicles travel to destinations within 0.75-mile of fixed route bus services for any purpose.

The Boston Hospital Transportation (BHT) is another healthcare transit service. Services are provided from Wellfleet, Eastham, Orleans, Harwich, Barnstable, and Sagamore to 15 Boston-area medical facilities by appointment.

### Annual CCRTA Ridership Counts

CCRTA systemwide ridership counts for the last 27 years show a considerable increase in public transit use throughout Cape Cod. Exhibit 2-44 shows that the CCRTA provided just over 357,000 passenger trips in 1989. By 2016, ridership had more than tripled, reaching nearly 1.3 million annual passenger trips.

**Exhibit 2-44 Cape Cod Regional Transit Authority (CCRTA) Annual Ridership**



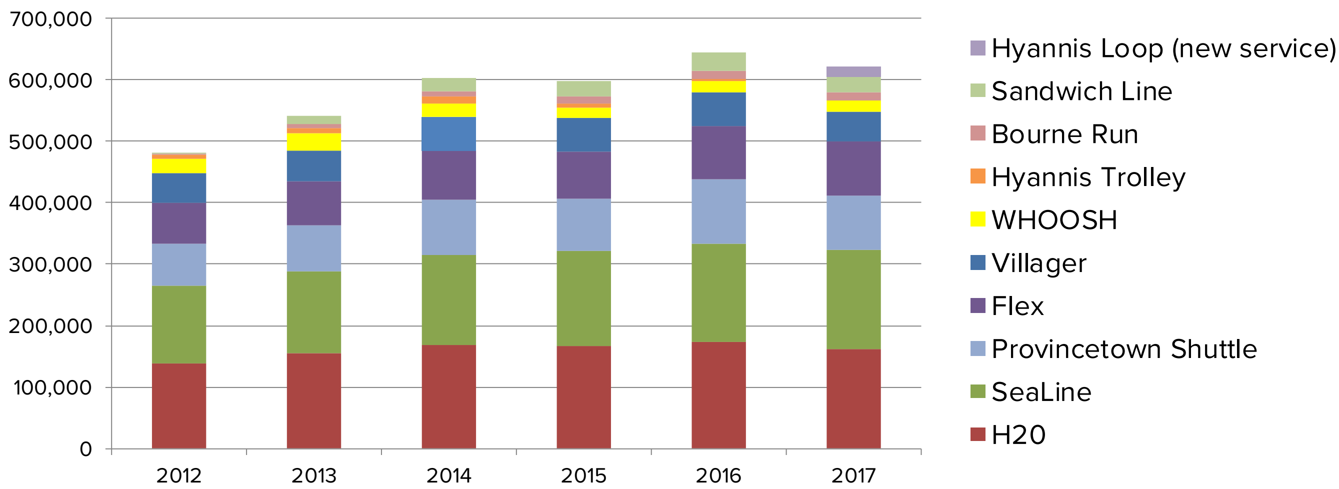



***Exhibit 2-45 Cape Cod Regional Transit Authority (CCRTA) Fixed Route Ridership***

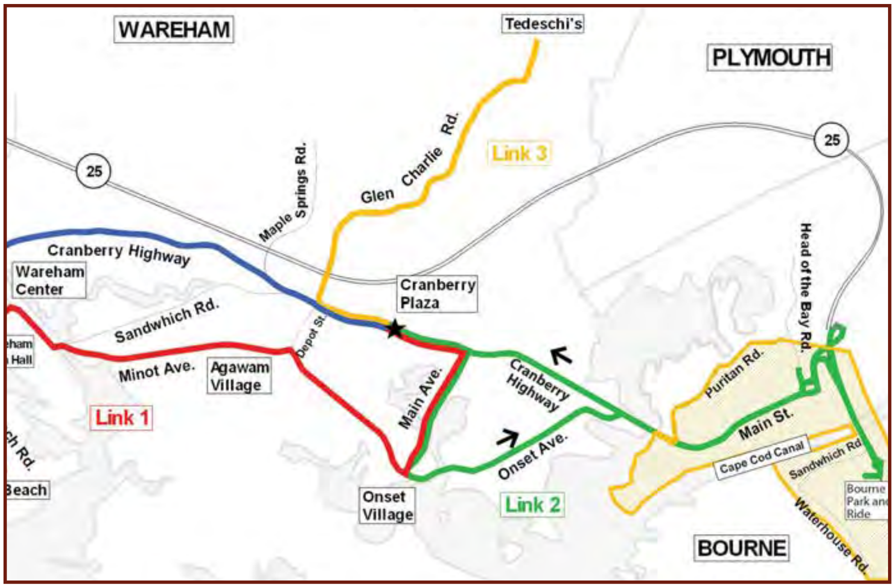
The annual CCRTA counts in Exhibit 2-44 represents trips by all CCRTA services— fixed-route and seasonal services, and demand-response, human service transportation and ADA passenger trips.

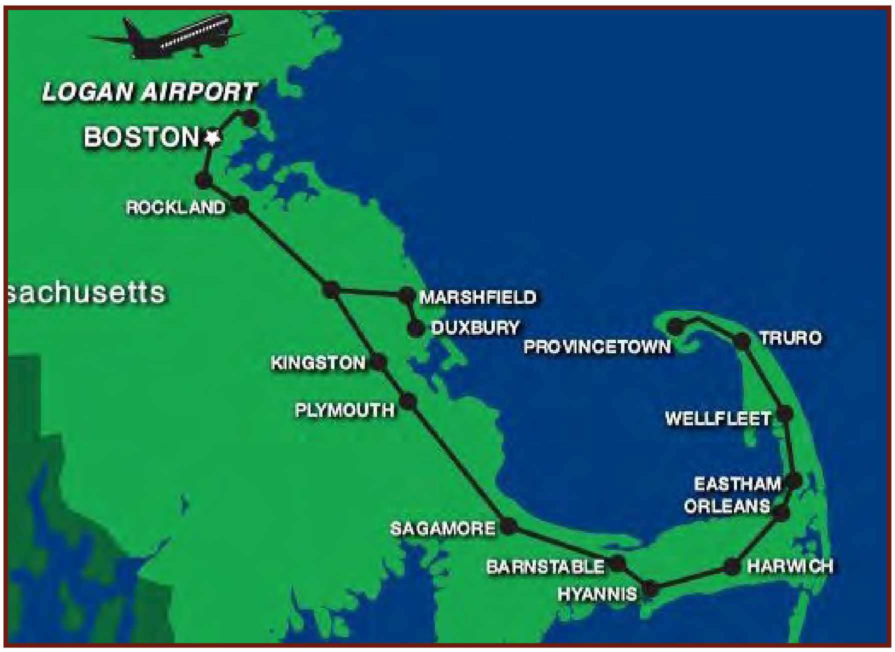
Exhibit 2-45 focuses on ridership for the CCRTA's fixed-routes for the period 2012-2017. This table shows that the routes with the highest ridership are the H2O and SeaLine, which travel the commercial corridor of Route 28. Both the Bourne Run and the Sandwich Line, introduced in 2012, experienced lower ridership than the more established fixed routes. Both lines experienced low ridership in 2012, their first year of operation; since then, however, annual ridership for the Sandwich Line shows a considerable increase. The Bourne Run has experienced slower ridership growth.

### *Greater Attleboro Taunton Regional Transit Authority (GATRA)*

GATRA is a public authority that provides transit service through southern Norfolk County, Plymouth County, and the South Shore. The Wareham/Middleborough/Lakeville Train Connector bus route runs from the Lakeville MBTA commuter rail station/ Cape Flyer station to Onset Town Pier and connects to the CCRTA Bourne Run route at Cranberry Plaza in Wareham. The Plymouth Area Link has four lines that connect the Plymouth and Kingston MBTA commuter rail stations to the Plymouth & Brockton Bus in Plymouth at Route 3 (Exit 5). As shown in the route map, GATRA provides bus service in the study area in Wareham, Plymouth, and Bourne.

One shuttle links Wareham Center with Onset, while another shuttle connects with Marion and Mattapoisett.




*(top to bottom)*
*GATRA Route Map*

*Plymouth & Brockton Bus Route, Provincetown to Logan Airport, Boston*

## *Plymouth & Brockton Street Railway Co.*

The Plymouth and Brockton Street Railway Co. ("Plymouth & Brockton Bus") is another privately-owned transportation company that runs four bus routes between Boston and Provincetown. One route runs from Hyannis to Boston's Logan International Airport via Barnstable, Sagamore, Plymouth, Rockland, and Boston. This route runs 16 times a day on weekdays with additional trips on the same route beginning and ending at South Station. These routes stop at Park and Ride lots on Route 6, providing daily service to Boston for commuters. On weekends the service runs 15 times a day. A second route connects from MacMillan Pier in Provincetown to New York City via New Bedford and Providence. An additional

line connects the outer Cape from Provincetown to the Hyannis Transportation Center via North Truro, Truro, Wellfleet, South Wellfleet, North Eastham, Eastham, Orleans, and Harwich. A separate route extends from Logan Airport in Boston to the Hyannis Transportation Center. Both the Provincetown-to-Hyannis line and the Hyannis-to-New York line run twice daily in both directions. Peak period congestion on the Route 6 – Route 3 corridor, particularly along the approaches to the Sagamore Bridge, can contribute to reduced reliability of these bus services.

#### *Peter Pan Bus Line*

Peter Pan Bus Line is a privately-owned transportation company that provides weekend service between Cape Cod and Boston a minimum of five times daily, with increased frequency on weekdays and during the summer. One route runs from Woods Hole to Logan Airport via Falmouth, Bourne, Buzzards Bay, Wareham, and Boston. A second route runs from the MacMillan Pier in Provincetown to New York City via Barnstable, Bourne, New Bedford, Fall River, and Providence. Peak period congestion on the Route 6 – Route 3 corridor, particularly along the approaches to the Sagamore Bridge, can contribute to reduced reliability of these bus services.

#### *Other Transit Authorities*

In addition to the transit services offered on Cape Cod, Nantucket and Martha's Vineyard each have their own transit system that runs year-round. The Nantucket Regional Transit Authority runs the WAVE with ten routes that originate near the Steamship Authority dock in Nantucket. The Martha's Vineyard Regional Transit Authority runs 13 routes throughout the island's six towns.

### 2.6.5 Rail

The MBTA provides summer weekend service to Cape Cod (Cape Flyer) through the Middleborough/Lakeville commuter rail line. The service runs from South Station in Boston to the Hyannis Transportation Center with stops in Braintree, Brockton, Middleborough/Lakeville, Wareham Village, and Buzzards Bay. The total trip from Boston to Hyannis takes approximately 2 hours and 20 minutes and costs $22 one way and $40 round trip. During its first season, 2013, the service had 16,586 passenger trips from May through October. For 2014 and 2015, the train serviced 12,625 and 13,278 passenger trips, respectively, from May through September. Passenger trips increased in 2016 to 14,499, an average of 9.2% more passenger trips than 2015.

*Cape Flyer traveling over the Cape Cod Canal*
*Source: Debee Tlumacki for the Boston Globe*

### 2.6.6 Ferry Service

Ferries provide year-round connections from Cape Cod to Nantucket and Martha's Vineyard via terminals at Woods Hole or Hyannis. Seasonally, ferries also run between Boston and Provincetown's MacMillan Pier. The Steamship Authority (SSA) operates year-round service and licenses private ferry operators to provide year round and seasonal ferry services from the mainland to the islands. SeaStreak, LLC, and Hyannis Harbor Tours, Inc. (Hy-Line) each has a license agreement with the SSA to operate ferry service. Both agreements were amended for the 2016 season, as described below.

The Steamship Authority terminal at Woods Hole

The SSA amended the SeaStreak license agreement to allow two daily round trips Monday through Thursday, and three daily round trips Friday through Sunday, during the summer. The trips run directly between New Bedford and Nantucket (in addition to the summer high-speed passenger service that SeaStreak provides between New Bedford and Martha's Vineyard). The crossing from New Bedford through Buzzards Bay, Vineyard Sound, and Nantucket Sound takes just under two hours.

Hy-Line Cruises also operated in 2016 under an amended license agreement with the SSA to provide ferry service from Hyannis Harbor to Nantucket and Oak Bluffs, Martha's Vineyard and between the islands. Under the amended agreement, Hy-Line will retire its 520-passenger ferry, the Brant Point, which provided one daily round trip on a seasonal basis between Hyannis and Oak Bluffs. It will substitute the Brant Point with a new high-speed passenger ferry (with a capacity of 300-350 passengers) running up to five daily round trips between Hyannis and Oak Bluffs on a seasonal basis. Hy-Line will also provide up to three daily round trips with the Lady Martha on a seasonal basis between Oak Bluffs and Nantucket (inter-island service) in addition to providing one morning daily trip from Hyannis to Oak Bluffs and an evening daily trip from Oak Bluffs to Hyannis.

Freedom Cruise Line, Inc. runs ferries between Harwich Port and Nantucket from Memorial Day weekend through September. During June and September, the ferries run one round trip a day; in July and August the ferries run three round trips per day.

Bay State Cruise Company runs a ferry and fast ferry service from Boston to MacMillan Pier in Provincetown from mid-May through mid-October. The fast ferry runs three round trips a day, with an additional early Monday morning service. The traditional ferry runs one round trip during the first three Saturdays in July.

The SSA itself runs ferries year-round from Woods Hole to Martha's Vineyard and from Hyannis to Nantucket. Off-season

ferries between Woods Hole and Vineyard Haven run 14 times a day. During the summer, ferries between Woods Hole and Vineyard Haven run nine to ten times a day with an additional four to five trips from Woods Hole to Oak Bluffs. The fare for adults is $8.50 one way and $17 round trip. The round-trip passage fare for vehicles ranges from $87 to $157 depending on the time of year and length of vehicle.

The SSA also runs a high-speed (60 minutes) passenger-only ferry from Hyannis to Nantucket. It runs four-round trips a day, April through mid-May and mid-October through December, and five round trips a day from late May through mid-October. The fare for adults is $36.50 one way and $69 round trip. Traditional ferry service also connects Hyannis to Nantucket. That ferry runs three round trips a day, mid-September through late May, and six round trips a day from late May through mid-September. The fare for adults is $8.50 one way and $17 round trip.

The SSA also runs ferries between Hyannis and Nantucket year-round. During the off season, September through May, the ferries run four round-trips per day. From June through August, they run six round-trips per day. All Steamship Authority ferries except the high-speed ferry carry passenger vehicles.

### *Steamship Authority Ferry Ridership*

The number of passengers and automobiles transported by the SSA has increased significantly during a seven-year period, from 2011 to 2017 (Table 2-24). The only year-to-year decrease came between 2016 and 2017, when there was a slight decrease in the number of passengers and automobiles served. In comparison, the number of trucks carried on these routes decreased between 2011 to 2012, and subsequently increased each year between 2012 and 2017.

Table 2-24 shows that the SSA's vessels transported a total of 3,059,049 passengers, 481,425 automobiles, and 189,388 trucks of all sizes to and from the islands of Martha's Vineyard and Nantucket during 2017.

Table 2-25 presents a monthly summary of passengers transported on SSA vessels during 2016 and 2017. The lowest SSA passenger counts were experienced in the winter months

*Table 2-24 Steamship Authority Ferry Ridership*

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Passengers | 2,712,047 | 2,802,980 | 2,846,691 | 2,893,851 | 3,023,090 | 3,127,304 | 3,059,049 |
| Automobiles | 439,721 | 449,850 | 452,286 | 457,682 | 465,297 | 482,699 | 481,425 |
| Trucks | 154,380 | 153,757 | 162,148 | 166,577 | 172,861 | 182,099 | 189,388 |

*Source: Massachusetts Steamship Authority*

Table 2-25 Steamship Authority Ridership - Monthly Trends 2014 to 2015

| | 2016 | 2016 | CHANGE |
|---|---|---|---|
| January | 103,577 | 115,333 | 0.6% |
| February | 104,494 | 103,861 | -0.6% |
| March | 130,505 | 120,872 | -7.4% |
| April | 185,330 | 199,140 | 7.5% |
| May | 288,863 | 283,282 | -1.9% |
| June | 346,631 | 334,141 | -3.6% |
| July | 503,565 | 466,429 | -7.4% |
| August | 503,239 | 498,235 | -1.0% |
| September | 343,569 | 319,418 | -7.0% |
| October | 264,043 | 274,912 | 4.1% |
| November | 179,606 | 183,154 | 2.0% |
| December | 162,776 | 160,272 | -1.5% |
| **Total** | **3,127,304** | **3,059,049** | **-2.2%** |

*Source: Massachusetts Steamship Authority*

of January and February. The highest passenger counts, in both 2016 and 2017, were in July and August. There were significant decreases during March (-7.4%), July (-7.4%), and September (-7.0%). Though overall ridership decreased approximately 2% between 2016 and 2017, there was a significant increase during the month of April (+7.5%). There were also slight or moderate increases during several other months: January (+0.6%), October (+4.1%), and November (+2.0%).

### *Steamship Authority Capital Improvements (2015-2016)*

The SSA completed several capital improvement projects in 2015, including the construction of a 1,900-space pervious-pavement parking lot on Landers Road in West Falmouth. This new lot allowed for the closure of two existing lots on Gilford Street in Falmouth, reducing traffic congestion in downtown Falmouth and creating a much more functional and efficient parking and shuttle bus operation for the SSA. The SSA also completed traffic-circulation improvements at its Vineyard Haven terminal.

The SSA christened a new ferry in June 2016. The M/V Woods Hole is a hybrid 235-foot vessel designed to carry up to 10 full-length tractor trailers trucks, 55 passenger vehicles, or some combination of both. The new boat can also carry 384 passengers, including a crew of nine. Finally, design and permitting for a multi-year, multi-phase reconstruction of the Woods Hole Terminal has been completed; construction of an initial phase is scheduled to start in early 2017.

### *Steamship Authority's New Bedford-to-Martha's Vineyard Freight Ferry Feasibility Study*

In April 2016 the SSA completed a draft feasibility study of providing freight ferry service between New Bedford and Martha's Vineyard. As noted above, truckers destined to Martha's Vineyard currently cross one of the Canal highway bridges and make their way south through Falmouth to the SSA terminal at Woods Hole. The primary reason for considering freight ferry service from New Bedford is to divert trucking from the Woods Hole terminal, thereby reducing the number of trucks traversing Falmouth.

A prior 2000-2001 freight ferry pilot program was not financially successful, with collected revenues covering only 15% to 22% of the cost of the service. However, in 2015 the SSA decided to reexamine the issue and initiated a comprehensive study of potential freight service between New Bedford and Martha's Vineyard. The study examined numerous issues related to this potential service including whether it should be year-round or season and whether it should be financially self-supporting.

## 2.6.7 Airline Service

Barnstable Municipal Airport

The Barnstable Municipal Airport serves flights by two major airlines, Cape Air and JetBlue. Cape Air flies from Hyannis to Nantucket and Boston year-round up to 12 round-trip flights a day. From May through October the airline also flies from Hyannis to Martha's Vineyard. JetBlue Airlines flies one round trip a day between New York City and Hyannis seasonally.

The Martha's Vineyard Airport offers flights from four carriers: Cape Air, Delta, JetBlue, and American. These airlines fly direct to New York City, White Plains, Washington D.C., New Bedford, Boston, Nantucket, and Hyannis, though schedules vary seasonally. Tradewind Aviation also runs shuttle flights May through October to New York City and White Plains.

The same four airlines serve Nantucket Memorial Airport: Cape Air, Delta, JetBlue, and American. Flights from Nantucket to Hyannis, Martha's Vineyard, Boston, and New Bedford are available year-round, while White Plains flights run seasonally. Tradewind Aviation also runs shuttle flights, April through December, to New York City and White Plains.

The Provincetown Municipal Airport has flights through Cape Air year-round to Boston and June through September to White Plains.

## 2.6.8 Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) refers to information technology applied to mitigate transportation congestion and improve traveler safety. These systems provide the public with the latest information on construction, traffic congestion, accidents, and weather via signs posted along the highway.

In April 2014 a "GO Time" real time traffic information system became operational along Route 6 on Cape Cod. This system anonymously tracks Bluetooth signals from vehicles to measure average vehicle speeds and travel times between points. Approaching Cape Cod and along Route 6 across the Cape, permanent federal highways signs with embedded digital displays show projected travel times to exits. MassDOT intends to continue to improve the ITS infrastructure on Cape Cod in the future.


*Real time traffic information sign along Route 6 in Orleans*

## 2.6.9 Park & Ride Lots

Park & Ride lots offer commuters and others the ability to carpool or use transit services on Cape Cod. Exhibit 2-46 shows the three Park & Ride lots within the study area and a fourth lot at Route 6 Exit 6. One is located at the Route 25 eastbound off-ramp at Exit 2 in Wareham. Operated by MassDOT, it has 120 spaces. Peter Pan Bus Lines operate a commuter bus service from Woods Hole to Logan Airport via South Station that stops at the Wareham lot twice on weekdays and once on weekends in each direction.

***Exhibit 2-46 Rest Area and Park & Ride Lots in Study Area***

A second Park & Ride lot in the study area, known as the Sagamore lot, is located north of the Cape Cod Canal at the southeast corner of the Route 3/Route 6 (Scenic Highway) interchange in Bourne. The lot is owned by MassDOT has a capacity of 377 vehicles. This lot is often at or near capacity year-round. The lot is serviced by the Plymouth & Brockton Bus Company, which runs buses from Hyannis to Boston, with stops including the Bourne Park & Ride lot.

The study team conducted a mid-week occupancy count at the Sagamore lot in October 2016. Their findings confirmed earlier counts, that the lot was 99% occupied. Finally, while outside the study area, a larger (365 spaces) Park & Ride lot is located at Route 6 Exit 6 in Barnstable. Based on this occupancy survey, it appears that the opportunity exists to either increase the number of parking spaces at existing park and ride lots or construct an additional park and ride lot along Route 6. Additional parking spaces, or a new parking lot located on-Cape would be preferable to reduce the need for vehicles to travel over the Sagamore Bridge.

### 2.6.10 Rest Areas

Rest areas provide locations for drivers to temporarily pull off major roads. They provide restroom facilities and tourist information. Exhibit 2-46 shows the rest areas within the study area. A tourist information center is located at the Park & Ride lot in the southeast corner of the Route 3/Route 6 (Scenic Highway) interchange, in Bourne. Another tourist information center is located between Exits 2 and 3 on Route 25 eastbound. In Sandwich, a small information center with parking sits north of Exit 2 off Route 6.

Along Route 6/Scenic Highway in Bourne there are two rest areas with parking and picnic tables and one at the Herring Run Recreation Center, owned and operated by the U.S. Army Corps of Engineers. This parking area also has paths that connect to the Cape Cod Canal Trail for recreational use.

## 2.7 SUMMARY OF EXISTING CONDITIONS

Chapter 2 provided a description of the existing natural and cultural conditions in the study area including the existing natural and cultural environmental resources, land uses, socio-economic conditions, public health and transportation.

#### *Natural Environmental Resources*

The study area features an abundance of natural environmental resources particularly coastal and inland wetlands north and

south of the Canal. Project area wetlands, floodplain, and waterbodies such as the Canal, Herring Pond, Buttermilk Bay are critical for supporting recreation, fishing, shellfishing, wildlife habitat, and flood control.

Rare species habitat is prevalent throughout the study area, particularly within Joint Base Cape Cod and the Shawme-Crowell State Forest. The rare species include a wide variety of turtles, reptiles, birds, butterflies, moths, mussels, and plants. Numerous certified and potential vernal pools also exist throughout the study area.

The study area also features two Areas of Critical Environmental Concern (ACEC); the Bourne Back River and the Herring River ACECs. Aquifers on Cape Cod are a particularly sensitive resource as they are part of a designated drinking water sole source aquifer.

### *Social Environmental Resources*

The study area features numerous social environmental resources such as historic sites and open space.

Concerning historic resources, the study area, including Bourne, Plymouth, Sandwich, and Wareham, is rich in historic resources and open space properties. The historic sites include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich. Several public buildings are Bourne are individually listed on the National Register of Historic Places including the Bourne High School, the Jonathon Bourne Public Library, Bourne Town Hall.

There are many publicly- and privately-owned parcels which are protected as open space. These publicly- and privately-owned properties serve a wide variety of purposes, including watershed protection, wildlife habitat, conservation, recreation, public beaches, marinas, and camping. Open space properties in the study area include the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

The predominately-forested Joint Base Cape Cod dominates the central portion of the study area. The numerous historic and archaeological sites reflect the area’s long and rich history. While these environmental resources contribute to the great appeal of Cape Cod, they also represent a constraint on future transportation improvement alternatives.

### Socio-Economic Conditions and Public Health

Socio-economic conditions in Barnstable County (Cape Cod) are in transition. After several decades of rapid population and employment growth, the county has experienced a population decline since 2000. The demographics of this population is also shifting to a higher percentage of senior citizens and a lower percentage of working adults and school-age children. The unemployment rate in Barnstable County is similar to the rate in Massachusetts as a whole, but it fluctuates widely during the year, with a lower rate during the summer tourist season and a higher rate during the off season. The unemployment rate generally held steadier closer to the Canal area (and employment centers in Plymouth County and beyond).

The predominate health problems in Barnstable County include asthma, heart disease, diabetes, and depression. The method workers use to commute to work is an important issue in Barnstable County. Nearly 90% of commuters use private automobiles to travel to work. Crossing the two roadway bridges over the Canal represents an important part of the daily commute for many residents in Barnstable County. Nearly 34,000 commuters cross one of the Canal bridges each work day as part of their daily commute, including over 32% of workers in Bourne and 19% of workers in Sandwich.

### Utilities

Important utility corridors cross the study area. These include an electrical utility corridor which transmits electricity through transmission towers from the Canal Generating Plant in Sandwich northwest across the Canal and east to Cape Cod customers. Natural gas enters Cape Cod within a pipe network that crosses the Canal attached to the Canal bridges. Natural gas compressor stations are located close to both the Sagamore and Bourne Bridges.

### Joint Base Cape Cod

South of the Canal, Joint Base Cape Cod (JBCC) is a nearly 21,000-acre full scale, joint-use base home to five military commands training for missions at home and overseas, conducting airborne search and rescue missions, and intelligence command and control.

### Multimodal Facilities

Cape Cod is well served by multimodal facilities including transit, air, bicycle and pedestrian facilities. Transit services on Cape Cod include public- and private-bus services and seasonal commuter rail. The Hyannis Transportation Center serves as an

important regional transportation hub. Barnstable Municipal Airport provides airline service to Nantucket, Boston, New York and beyond. The Massachusetts Steamship Authority provides a robust ferry service with regular ferries between Cape Cod and Nantucket and Martha's Vineyard. Seasonal ferry service is also provided between Provincetown and Boston.

Sidewalks are generally present for pedestrians in more densely developed residential and commercial areas but absent elsewhere. Sidewalks along major travel corridors in the focus area include those along the southern side of Scenic Highway from Nightingale Road west along the southern edge of Belmont Circle and continuing through the Main Street business district in Bourne.

Many other roads in the study area are narrow (20–22 feet) and lack sidewalks. This presents difficulties for pedestrians, particularly the elderly or those with disabilities. Major roadways in the study area, such as Route 28, Route 151, Route 130, Buzzards Bay Bypass, Sandwich Road, Tupper Road, Shore Road, County Road, and Scenic Highway (except in the immediate area of the Route 3 interchange) generally lack sidewalks.

Existing bicycle facilities in the study area include the USACE's Cape Cod Canal bike paths, which runs on both the north and south sides of the Canal. While somewhat outside of the study area, the Shining Sea Bike Path runs through Falmouth along an out-of-service Woods Hole Branch rail right-of-way. The path runs for 10.6 miles from the Steamship Authority terminal in Woods Hole to County Road (Route 151) in Falmouth. An on-road bike route is designated on Route 6A in Sandwich.

### *Traffic Study Findings*

Existing traffic conditions during peak hours along highways in the focus area is often characterized by substantial traffic volumes and congestion (LOS D). There are also numerous roadway intersections that experience severe congestion (LOS E and F) during summer and non-summer peak hours. There are five HSIP high crash locations in focus area.

As described in Section 2.5.6, the highest daily and peak hour traffic volumes in the study area occur along the major highway corridors in the study area, including the Route 3/Sagamore Bridge/Route 6 corridor and the Route 25/Bourne Bridge/Route 28 corridor. Average daily traffic (ADT) on the bridges are generally 30% to 40% higher in the summer compared to the non-summer period. Traffic volumes range from 55,000 to 65,000 vehicles in the summer and 38,000 to 41,000 in the non-summer periods, with the Sagamore Bridge generally having the higher traffic volumes.

The roads connecting the bridge approaches (Scenic Highway north of the Canal and Sandwich Road south of the Canal) also experience high traffic volumes and congestion. This is the result of high traffic volumes within the focus area (not just travel through the focus area) and many travelers crossing from one of the travel corridor to the other.

Exacerbating this congestion is the inadequate capacity and sub-standard design at the intersections at the bridge approaches. These gateway intersections include Belmont Circle and Bourne Rotary (north and south of the Bourne Bridge) and Route 6 Exit 1C south of the Sagamore Bridge. These intersections and several others in the focus area experience extended queueing and poor LOS during the summer and non summer periods (see Sections 2.5.8 and 2.5.10). The roadway geometry on Route 3, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays, especially during peak travel periods.

More frequent maintenance on the Canal bridges, with the resultant lane closures, also contributes to off-season traffic congestion. Congestion on the Canal bridges negatively effects the daily commute of the over 34,000 commuters who cross the Canal every work day.

## 2.8 ISSUES, CONSTRAINTS, AND OPPORTUNITIES

Based on the information gathered in Chapter 2, including existing natural and cultural environmental resources, socio-economic and demographic data, and the traffic study, a series of issues, constraints, and opportunities in the study area were identified (as listed below) which provide a framework for the alternatives development process described in Chapter 4.

*Issues:*

1. **Severe congestion at Gateway Intersections at Canal bridge approaches**

   Transportation conditions in the focus area are characterized by substantial congestion and delay, particularly during periods of high traffic volumes in the summer tourist season. Traffic conditions at the gateway intersections, including Belmont Circle, Bourne Rotary, the highway approaches to Route 6, and the Route 6 Exit 1C entrance ramp, are exacerbated by substandard roadway geometry. Peak period congestion also reduces the reliability of transit services.

This congestion may also negatively affect seasonal tourism as some people choose other, less congested vacation destinations.

Additionally, the roadway geometry on Route 3, including the dropping of a travel lane on Route 3 southbound and the narrow travel lanes with no roadway shoulder on the Sagamore Bridge, contributes to congestion and delays, especially during peak travel periods.

Peak period congestion in the Canal area affects the nearly 34,000 commuters who cross one of the Canal bridges each work day as part of their daily commute, including over 32% of workers in Bourne and 19% of workers in Sandwich.

2. **High Crash Rates in Study Area**

   Eight locations within the study area rank as high-crash locations under the Highway Safety Improvement Program (HSIP). This MassDOT designation identifies crash clusters that rank within the top five percent of their respective regional planning agency's crash locations. The locations in the study area with the highest crash rates include Belmont Circle, Bourne Rotary, and the intersections of Route 6A at Route 130 and Scenic Highway at Meetinghouse Lane.

3. **Balancing visitor and resident needs**

   It will be important to develop alternatives that improve regional travel while retaining the character of Cape Cod. Designing transportation improvements to accommodate the summertime peak period traffic levels would require very substantial infrastructure improvements, likely considered an 'over-build' not be in keeping with the type or scale of development desired on Cape Cod.

4. **Lack of population growth and aging population**

   Peak period congestion, particularly at the Canal bridges, decreases the reliability of the transportation system. This inhibits the growth of Cape Cod businesses and may contribute to the stagnation of population growth. The population of Barnstable County has not grown since 2000 and has actually experienced a minor population decrease. Age cohorts in the county have also shifted since 2000 with a substantial decrease in the population of working-age adults and school-age children with a corresponding increase in senior citizens.

5. **Lack of bicycles and pedestrian accommodation and connections**

   The study area suffers from a lack of bicycle and pedestrian facilities and connections between the existing facilities. Other than the Canal bike path, there are few bicycle facilities in the study area. Accessible connections to the Canal path are often lacking. Sidewalks for pedestrians are also often absent outside of more densely developed residential and commercial areas in Bourne and Sandwich. This lack of sidewalks is especially problematic along bus routes in the study area.

### *Constraints:*

1. **Extensive areas of sensitive environmental resources**

   The abundance of natural and social environmental resources in the study area. Natural environmental resources include coastal and inland wetlands north and south of the Canal; Herring Pond, Buttermilk Bay and other waterbodies; floodplains, and rare species.

   Areas of Critical Environmental Concern (ACEC), recreational, commercial fishing and shellfishing, and the numerous historic sites in the study area also represent a constraint on future transportation improvements. Aquifers on Cape Cod are a particularly sensitive resource as they are part of a designated sole source aquifer.

   Social environmental constraints include publicly- and privately-owned open space parcels, including the Scusset Beach State Reservation, Shawme-Crowell State Forest, Upper Cape Water Supply Reserve, Cape Cod Canal Recreation Area, Gallo Skating Rink, Carter Beal Conservation Area, Sacrifice Woods Rock, and the Nightingale Pond Recreation Area.

   Historic resources in the study area also represent a constrain to transportation improvements. The historic sites include the Bourne and Sagamore Bridges, the Old Kings Highway Regional Historic District in Sandwich, and the Jarvesville, Town Hall Square, and Spring Hill National Historic Districts in Sandwich.

2. **Developed residential and commercial area**

   Outside of areas of natural environmental resources, much of the study area contains dense residential and commercial development. This development along the region's major roadways represents a constraint of the expansion of these transportation facilities.

3. **Joint Base Cape Cod (JBCC, including the Upper Cape Water Reserve)**

   The 22,000 acres of JBCC, particularly the 15,000 acres of JBCC designated as the Upper Cape Water Reserve, represent a constraint on transportation improvements as use of this land for transportation purposes would require approval of the Massachusetts National Guard and the Massachusetts Legislature.

*Opportunities:*

1. **Collaboration between MassDOT and U.S. Army Corps of Engineers (USACE)**

   An opportunity for collaboration exists between MassDOT and the USACE to work together to exchange information to allow a more cost-effective and timely advancement of their agency and community transportation goals.

2. **Reduced Peak Period Congestion and Crash Rates**

   The opportunity exists to reduce peak period congestion and crash rates in the study area, reducing costs related to lost time commuting to work, school, shopping, etc. Reduced peak period congestion also increases the attractiveness of study area transit services by reducing travel times and improving reliability. Reducing crash rates would reduce the risk of property or injury for residents, workers, and visitors in the study area.

3. **Enhance multimodal accommodation**

   The opportunity exists to enhance multimodal transportation accommodation in the study area. While there is a robust transit network in the study area, including bus and ferry service, providing more accessible sidewalks and bicycle lanes, especially along bus routes, would encourage people to use other transportation modes. An additional multimodal facility (park and ride lot) on Route 6 in the study area could address demand for commuter car-pooling and bus travel.

4. **Improve employment opportunities**

   Improving transportation mobility on- and off-Cape Cod provides the opportunity to increase year-round employment on Cape Cod, reducing the seasonal variability in the unemployment rates.

# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

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# Future No-Build Transportation Conditions

## 3.1 INTRODUCTION

This chapter analyzes future (2040) no-build traffic conditions in the study area. Highway system improvements are typically designed to satisfy traffic demands forecast for 25 years in the future. As the traffic analysis for this study began in 2015, the year 2040 was selected as the design year. This analysis assumes that no substantial transportation improvements will be made in the study area between now and 2040, such as the construction of additional travel lanes, as well as new or reconstructed interchanges, intersections, or multimodal facilities. This 'no-build' alternative serves as the baseline for the comparison of future transportation improvements.

This transportation analysis includes:

- Average daily and peak-period traffic volumes to provide a better understanding of the locations that experience the most vehicular activity. Traffic volumes are provided for different times of day, on both weekends and weekdays, and during the summer and non-summer periods.

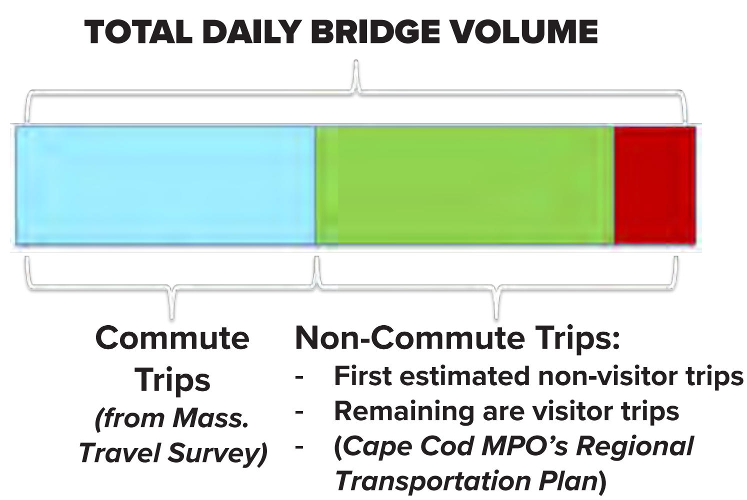
- Turning movement counts to quantify the movement of vehicles traveling through intersections.
- Measurements of efficiency (levels of service), including an analysis of traffic operations for a range factors, as described in Section 2.5.5.
- Detailed analysis of traffic operations of the Bourne Rotary and Belmont Circle.

## 3.2 FACTORS AFFECTING FUTURE TRANSPORTATION CONDITIONS

Projecting future travel demand requires an understanding of the socio-economic factors that lead to changes in traffic volumes. The primary contributors to traffic volumes in most locations are the daily commuting trips to work and school combined with non-commuting trips related to daily shopping, recreation, and other local destinations. As a major tourist destination, visitor travel to Cape Cod can contribute approximately 35% more vehicles on the Canal bridges during the summer compared to the non-summer. Therefore, as demonstrated in Exhibit 3-1, overall traffic volumes have two main components, daily local (commuting/non-commuting) trips and visitor trips.

The forecast 2040 commuter/non-commuter trips used for this study are based on socio-economic data provided by the Central Transportation Planning Staff (CTPS)[1] of the Boston Metropolitan Planning Organization (MPO). This socio-economic data is based

***Exhibit 3-1*** ***Visitors as a Percent of Traffic on Cape Cod Canal Bridges CTPS Method***




1 Destination 2040, Long-Range Transportation Plan, Boston MPO, Central Transportation Planning Staff

on forecast changes in population, employment, and housing. Known future developments, which would increase population and employment, are also included in this forecast. Increases (or decreases) in population and employment lead directly to similar changes in traffic volumes as more (or less) people are commuting to work or school or other daily trips.

The socio-economic data indicated only modest changes in the forecast population and employment levels in Barnstable County. The population of Barnstable County decreased by 2.8% between 2000 and 2010 but is forecast to increase very modestly (less than 1.0%) in this decade. Total employment in Barnstable County is also not projected to substantially increase in the coming decade.

Unlike commuter and non-commuter trips, there is no direct method to count visitor trips to Cape Cod. To estimate the changes in the volume in visitor trips, a non-direct method was used based on an economic analysis of trends in the hotel and restaurant industry as well as other factors. Based on this economic analysis, annual visitor trips to Cape Cod were forecast to increase within a range of 0.26% to 0.69% annually. To provide a conservative estimate, the higher 0.69% annual growth in visitors was used to forecast the growth in traffic volumes attributable to visitors. Based on multiple coordination sessions with the Cape Cod Commission, it was agreed that this was a reasonable forecast of visitor growth.

Overall, the combined forecast increase for all trips results in a 0.11% annual increase in vehicle trips during the non-summer weekday period and a 0.50% annual increase during the summer weekend (Friday - Sunday) period. This would result in an overall growth in traffic volumes of 30% in the summer period and 26% in the non-summer period between 2014 and 2040. These growth factors were applied to the existing (2014) traffic volumes to calculate future (2040) traffic volumes. A travel demand model (described below) was used to evaluate future no-build and build conditions.

***By 2040, traffic volumes in the study area are forecast to increase 30% in the summer period and 26% in the non-summer period.***

## 3.3 TRANSPORTATION

### 3.3.1 Regional Travel Demand Modeling

Future (2040) no-build traffic conditions in the study area were forecast using a regional travel demand model. To develop a transportation model of the study area, the Cape Cod Commission's (CCC) regional traffic model and portions of the CTPS regional traffic model were obtained. The network links for highways and transit, as well the existing traffic analysis zone

(TAZ) geographies, were reviewed and the model was updated as necessary within the study area. As described in Chapter 4, the travel demand model was also used to test the effectiveness of proposed transportation improvements.

A crucial step in the process of creating a regional travel-demand model is calibrating the model to replicate travel times on key routes crossing the Canal and existing traffic volumes on study area highways. The model-calibration not only replicates existing traffic counts but also attempts to match travel time data collected during the peak season by the BlueTOAD™ units (as described in Section 2.5.4.)

The model-calibration process gives the model the ability to assign traffic to specific routes through the study area during a wide variety of time ranges during summer and non summer periods. The model was calibrated to within 5% of the existing total two-way volumes on the two bridge crossings, in accordance with Federal Highway Administration (FHWA) and MassDOT guidelines.

### 3.3.2 Planned Transportation Improvements

To further refine the analysis of study area's transportation system, known planned transportation improvements were identified. The following projects within the study area are anticipated to be constructed as they are listed on the Cape Cod Commission's 2017 – 2021 Transportation Improvement Program (TIP).

- Sandwich (MassDOT Project No. 608422) Service Road Shared-Use Bike Path from Route 130 to Chase Road
- Bourne (MassDOT Project No. 606900) Belmont Circle Multimodal Improvements
- Wareham (MassDOT Project No. 608554) Resurfacing on Route 6 & 28 Bypass Road

### 3.3.3 Cape Cod Commission Regional Transportation Plan

The Cape Cod Commission serves as the Metropolitan Planning Organization (MPO) for Barnstable County. The MPO's Regional Transportation Plan (2016 – 2040) was reviewed to gain an understanding of the regional future priorities for all modes of transportation on Cape Cod. The following projects within the study area are listed in the MPO's long range plan.

**Highway/Roadway Improvements:**

- Belmont Circle to Route 25 Westbound Ramp
- Route 6 Exit 1C Reconfiguration
- Buzzards Bay Commuter Rail Infrastructure

**Multimodal Improvements:**

- Cape Cod Rail Trail Extension: Barnstable to Cape Cod Canal
- Shining Sea Bike Path Extension to Cape Cod Canal

***The AM weekday peak period is 7:00 - 9:00AM; the PM weekday peak period is 4:00 - 6:00PM; and the Saturday peak period is 10:00AM - 12:00PM.***

### 3.3.4 Future (2040) No-Build Average Daily Traffic Volumes and Peak-Period Traffic Volumes

This section presents the future (2040) no-build average daily traffic (ADT) volumes and the peak hour traffic volumes in the study area. Table 3-1 provides future ADT and peak-hour traffic volumes for the AM, PM, and Saturday periods for both summer and non-summer traffic. Exhibits 3-2 and 3-3 present future

*Table 3-1 Future (2040) No-Build Average Daily Traffic and Peak Hour Traffic Volumes*

| ATR COUNTING STATIONS | FUTURE (2040) NO-BUILD SUMMER | | | | FUTURE (2040) NO-BUILD NON-SUMMER | | | |
|---|---|---|---|---|---|---|---|---|
| | AM | PM | SAT | ADJUSTED ADT[1] | AM | PM | SAT | ADJUSTED ADT[1] |
| Bourne Bridge | 4,215 | 5,945 | 4,930 | 61,600 | 3,780 | 4,045 | 4,480 | 45,200 |
| Sagamore Bridge | 6,305 | 7,635 | 8,175 | 93,300 | 4,870 | 5,660 | 5,470 | 59,600 |
| Route 3 between Exits 1A and 2 | 4,895 | 6,430 | 5,530 | 72,400 | 3,910 | 4,890 | 4,840 | 51,800 |
| Route 6 between Exits 1 and 2 | 6,115 | 7,705 | 7,565 | 90,600 | 4,665 | 5,370 | 5,535 | 51,800 |
| Route 25 West of Exit 2 | 5,735 | 8,455 | 7,845 | 78,900 | 4,580 | 5,340 | 5,900 | 56,800 |
| Route 25 East of Exit 2 | 4,595 | 6,940 | 5,240 | 26,200 | 3,940 | 3,960 | 4,235 | 19,700 |
| Route 6 (Scenic Hwy) East of Nightingale Rd | 2,895 | 3,695 | 2,810 | 36,200 | 2,435 | 2,735 | 2,590 | 25,400 |
| Sandwich Rd East of Bourne Rotary Connector | 2,435 | 2,935 | 2,400 | 33,400 | 2,105 | 2,185 | 2,680 | 28,100 |
| Adams St South of Sandwich Rd | 400 | 350 | 275 | 11,800 | 345 | 380 | 420 | 13,900 |
| Buzzards Bay Bypass | 570 | 760 | 810 | 8,800 | 505 | 845 | 830 | 6,000 |
| Main St West of Perry Ave | 2,065 | 2,395 | 2,680 | 28,500 | 1,080 | 1,375 | 1,155 | 11,600 |
| Trowbridge Rd West of Veterans Way | 885 | 1,465 | 895 | 12,000 | 890 | 1,035 | 1,175 | 9,900 |
| Route 28 South of Bourne Rotary | 3,820 | 3,715 | 4,685 | 49,000 | 3,330 | 2,580 | 3,685 | 40,100 |
| Route 130 North of Route 6 | 845 | 980 | 1,170 | 12,500 | 610 | 770 | 1,875 | 13,200 |
| Route 6 between Exit 2 and 3 | 5,005 | 6,150 | 6,645 | 67,000 | 4,520 | 4,115 | 5,205 | 56,000 |
| Mid-Cape Connector South of Sandwich Rd | 1,380 | 1,855 | 1,800 | 28,500 | 1,380 | 1,600 | 1,825 | 18,100 |
| Route 6 East of Exit 3 | 4,995 | 6,395 | 7,330 | 70,900 | 3,905 | 4,405 | 5,375 | 53,400 |
| State Rd North of Ramp to Route 3 NB | 450 | 710 | 785 | 8,200 | 445 | 610 | 745 | 6,200 |
| Route 6A East of Cranberry Hwy | 765 | 1,500 | 1,760 | 15,100 | 655 | 790 | 1,240 | 8,300 |
| Route 3 between Exits 2 and 3 | 4,895 | 6,435 | 5,525 | 60,000 | 3,905 | 4,885 | 4,835 | 50,300 |
| Route 28 South of Exit 2 (Route 151) | 1,100 | 2,070 | 1,115 | 12,800 | 1,440 | 1,650 | 1,465 | 16,800 |

[1] *Average Daily Traffic (ADT)*

*Table 3-1 continues on the next page.*

*Table 3-1 Future (2040) No-Build Average Daily Traffic and Peak Hour Traffic Volumes*

| ATR COUNTING STATIONS | FUTURE (2040) NO-BUILD SUMMER | | | | FUTURE (2040) NO-BUILD NON-SUMMER | | | |
|---|---|---|---|---|---|---|---|---|
| | AM | PM | SAT | ADJUSTED ADT[1] | AM | PM | SAT | ADJUSTED ADT[1] |
| Route 3 NB Off Ramp to Herring Pond Rd | 230 | 425 | 225 | 3,100 | 190 | 335 | 310 | 2,500 |
| Route 3 SB Off Ramp to Herring Pond Rd | 385 | 645 | 945 | 7,900 | 465 | 605 | 925 | 3,400 |
| Route 3 SB Off Ramp to Scenic Highway | 375 | 730 | 430 | 5,000 | 535 | 685 | 700 | 6,200 |
| Route 6 EB Off Ramp to Mid-Cape Connector | 710 | 815 | 800 | 8,600 | 655 | 730 | 515 | 5,900 |
| Route 6 EB Off Ramp to Quaker Meeting House Rd | 415 | 295 | 275 | 1,700 | 170 | 230 | 225 | 2,100 |
| Route 6 EB Off Ramp to Route 130 | 695 | 995 | 735 | 15,700 | 685 | 935 | 670 | 7,200 |
| Route 6 WB Off Ramp to Cranberry Hwy | 410 | 660 | 220 | 3,800 | 405 | 510 | 535 | 2,400 |
| Route 6 WB Off Ramp to Meetinghouse Lane EB | 340 | 510 | 340 | 4,500 | 275 | 375 | 340 | 3,500 |
| Route 6 WB Off Ramp to Quaker Meetinghouse Rd | 125 | 345 | 655 | 2,300 | 240 | 400 | 265 | 2,500 |
| Route 6 WB Off Ramp to Route 130 | 175 | 215 | 225 | 2,000 | 195 | 245 | 810 | 4,200 |
| Route 6 WB Off Ramp to Scenic Hwy WB | 830 | 990 | 1,350 | 13,400 | 720 | 765 | 615 | 6,800 |
| Route 25 EB Off Ramp to Belmont Circle | 665 | 1,280 | 1,025 | 11,200 | 590 | 835 | 565 | 5,500 |
| Route 25 EB Off Ramp to Maple Springs Rd | 695 | 1,055 | 1,745 | 14,800 | 510 | 770 | 920 | 8,000 |
| Route 28 NB Off Ramp to Route 151 | 25 | 285 | 80 | 600 | 105 | 230 | 130 | 1,500 |
| Route 28 SB Off Ramp to Route 151 | 385 | 900 | 550 | 5,500 | 455 | 685 | 475 | 5,500 |
| Route 130 On Ramp to Route 6 EB | 165 | 135 | 145 | 1,800 | 185 | 160 | 155 | 1,400 |
| Route 130 On Ramp to Route 6 WB | 755 | 910 | 550 | 12,300 | 815 | 725 | 625 | 6,800 |
| Route 130 South of Route 6 | 2,045 | 2,555 | 2,025 | 28,600 | 1,970 | 2,235 | 2,345 | 21,100 |
| Route 151 On Ramp to Route 28 NB | 535 | 660 | 385 | 5,500 | 620 | 540 | 620 | 6,500 |
| Route 151 On Ramp to Route 28 SB | 155 | 225 | 100 | 1,600 | 260 | 230 | 240 | 2,600 |
| Belmont Circle On Ramp to Bourne Bridge | 800 | 785 | 1,115 | 11,800 | 825 | 785 | 1,175 | 9,800 |
| Belmont Circle On Ramp to Route 25 WB | 1,110 | 1,335 | 940 | 12,200 | 925 | 1000 | 1,070 | 9,600 |
| Bourne Bridge Off Ramp to Belmont Circle | 595 | 835 | 540 | 7,100 | 530 | 730 | 705 | 6,700 |
| Scenic Hwy EB On Ramp to Sagamore Bridge | 705 | 815 | 955 | 11,100 | 670 | 590 | 485 | 5,200 |
| Scenic Hwy WB On Ramp to Sagamore Bridge | 305 | 310 | 740 | 6,700 | 295 | 255 | 345 | 3,500 |
| Sandwich Rd West of Jillian Drive | 2,255 | 2,840 | 2,395 | 34,600 | 2,055 | 2,225 | 2,610 | 29,800 |
| Sandwich Rd East of Adams St | 1,095 | 1,505 | 1,365 | 14,900 | 1,030 | 1,255 | 1,275 | 9,200 |
| Cranberry Hwy On Ramp to Route 6 WB | 685 | 790 | 1030 | 11,100 | 585 | 780 | 1,020 | 8,500 |
| Mid Cape Connector On Ramp to Route 6 EB | 795 | 1,015 | 1,000 | 12,500 | 630 | 710 | 1,065 | 9,400 |
| Herring Pond Rd On Ramp to Route 3 NB | 425 | 455 | 445 | 5,500 | 735 | 460 | 575 | 6,300 |
| Herring Pond Rd On Ramp to Route 3 SB | 495 | 615 | 720 | 7,800 | 385 | 605 | 330 | 7,200 |
| Quaker Meeting House Rd On Ramp to 6 EB | 410 | 345 | 410 | 4,400 | 490 | 260 | 305 | 3,500 |
| Quaker Meeting House Rd On Ramp to Route 6 WB | 130 | 150 | 85 | 1,100 | 200 | 145 | 175 | 1,600 |
| Glen Charlie Rd On Ramp to Route 25 EB | 155 | 255 | 195 | 2,000 | 360 | 150 | 95 | 1,400 |
| Maple Springs Rd On Ramp to Route 25 WB | 820 | 1,050 | 1,275 | 11,000 | 780 | 610 | 990 | 8,700 |

[1] *Average Daily Traffic (ADT)*

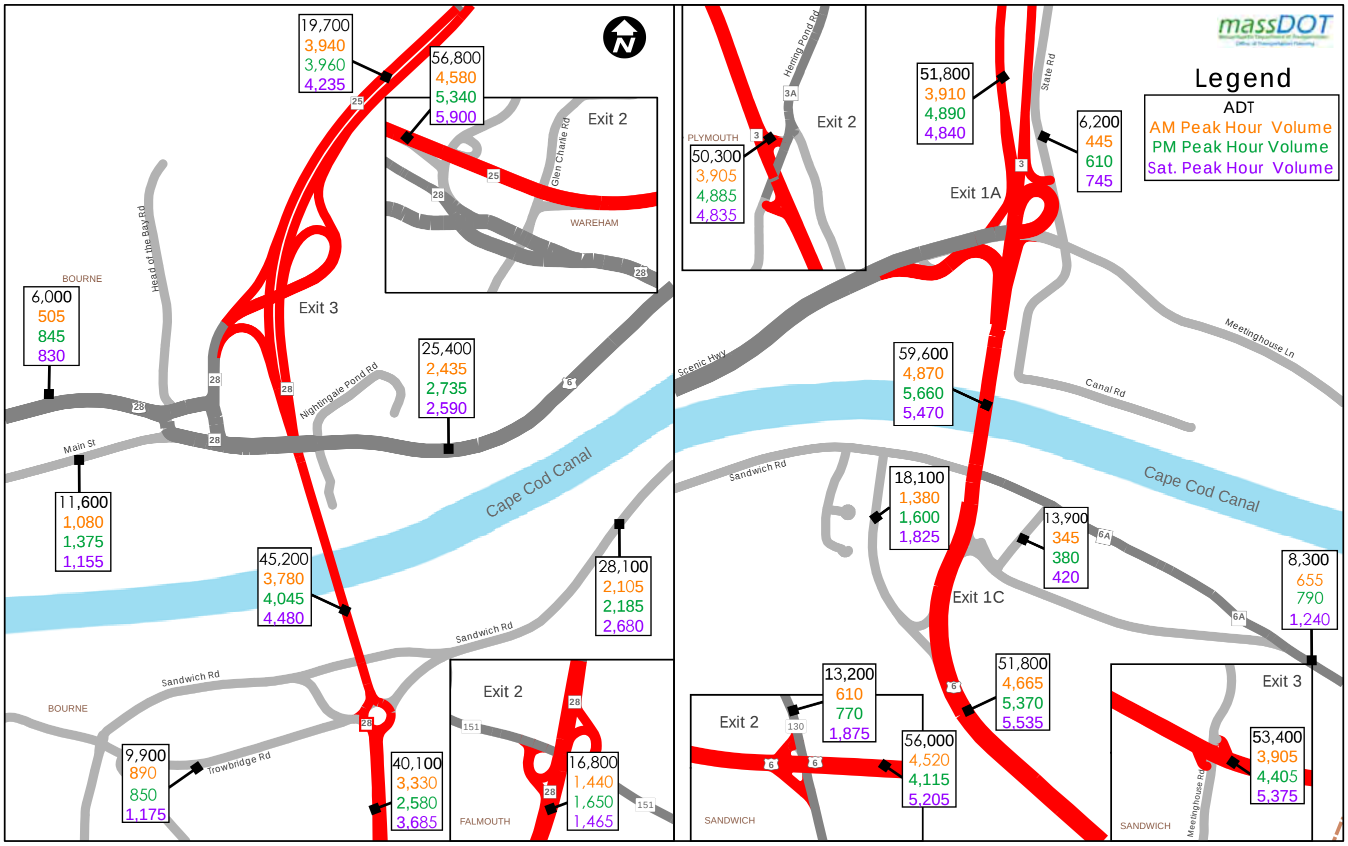
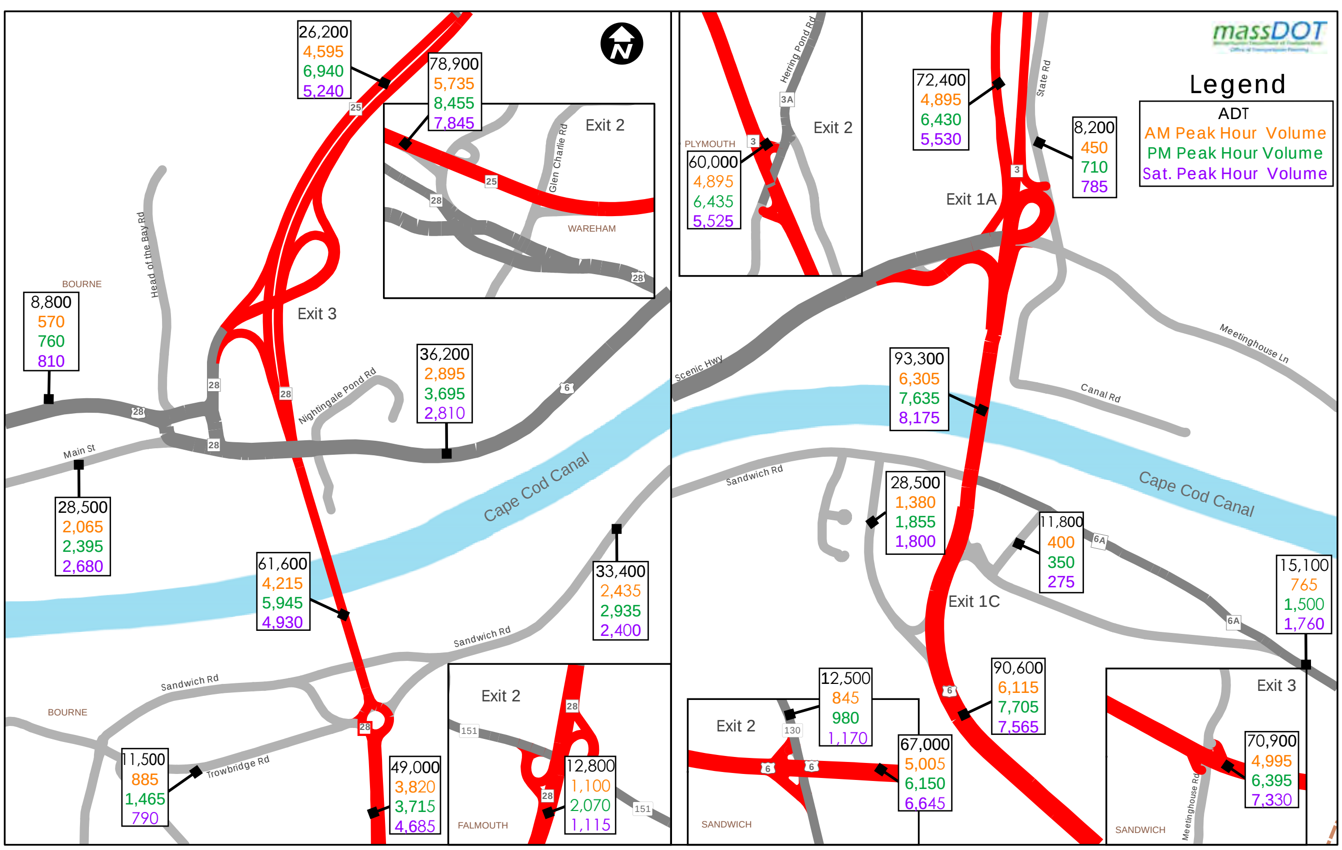



***Exhibit 3-2 Future (2040) Non-Summer Average Daily and Peak Period Traffic Volumes (AM/PM/Saturday)***

***Exhibit 3-3 Future (2040) Summer Average Daily and Peak Period Traffic Volumes (AM/PM/Saturday)***



summer and non-summer ADT and the AM, PM, and summer peak-hour traffic volumes at select locations in the study area. The ADT and peak-period traffic volumes for the existing condition are discussed in Chapter 2.5.6.

These exhibits show that, similar to the existing condition, the highest daily and peak-hour traffic volumes in the study area occur at the following locations:

- Major bridges (Sagamore and Bourne Bridges)
- Major highways (Routes 3, 6, 25, 28, and 130)
- Arterial roadways (Scenic Highway, Sandwich Road, and Main Street in Bourne).

*Summary of Future ADT*

As noted in Section 3.2, traffic volumes in the study area are forecast to increase approximately 30% in the summer period and 26% in the non-summer period between 2014 and 2040. This growth in traffic volumes will not be uniform throughout the study area; some locations will experience greater rates of growth than others.

Locations forecast to experience the greatest increase in traffic volumes include the Sagamore Bridge and other roadways in the immediate area of the bridge such as Route 3 (between Exits 1A & 2), Route 6 (between Exits 1 & 2), the Mid-Cape Connector, and State Road. Other areas of notable forecast traffic increases include Trowbridge Road, Route 28 (south of the Bourne Rotary), and Route 6 (between Exits 2 and 3). Table 3-2 also shows that traffic volumes are generally forecast to increase more in the non-summer period than in the summer period.

### 3.3.5 Turning Movement Counts

Turning movement counts (TMC) quantify the movement of vehicles traveling through intersections, including signalized intersections, stop-controlled intersections, and rotaries. The methodology for determining TMCs is provided in Section 2.5.3 and Exhibit 2-19 shows the location of the intersections for which TMCs are provided. Exhibits 3-4 through 3-9 display future (2040) TMCs for the AM, PM, and Saturday peak hours during the summer and non summer periods.

Turning Movement Counts are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow a LOS to be assigned for that location. The future (2040) TMCs are used to assign a LOS at signalized and unsignalized intersections in the study area (as presented in Section 3.3.6).

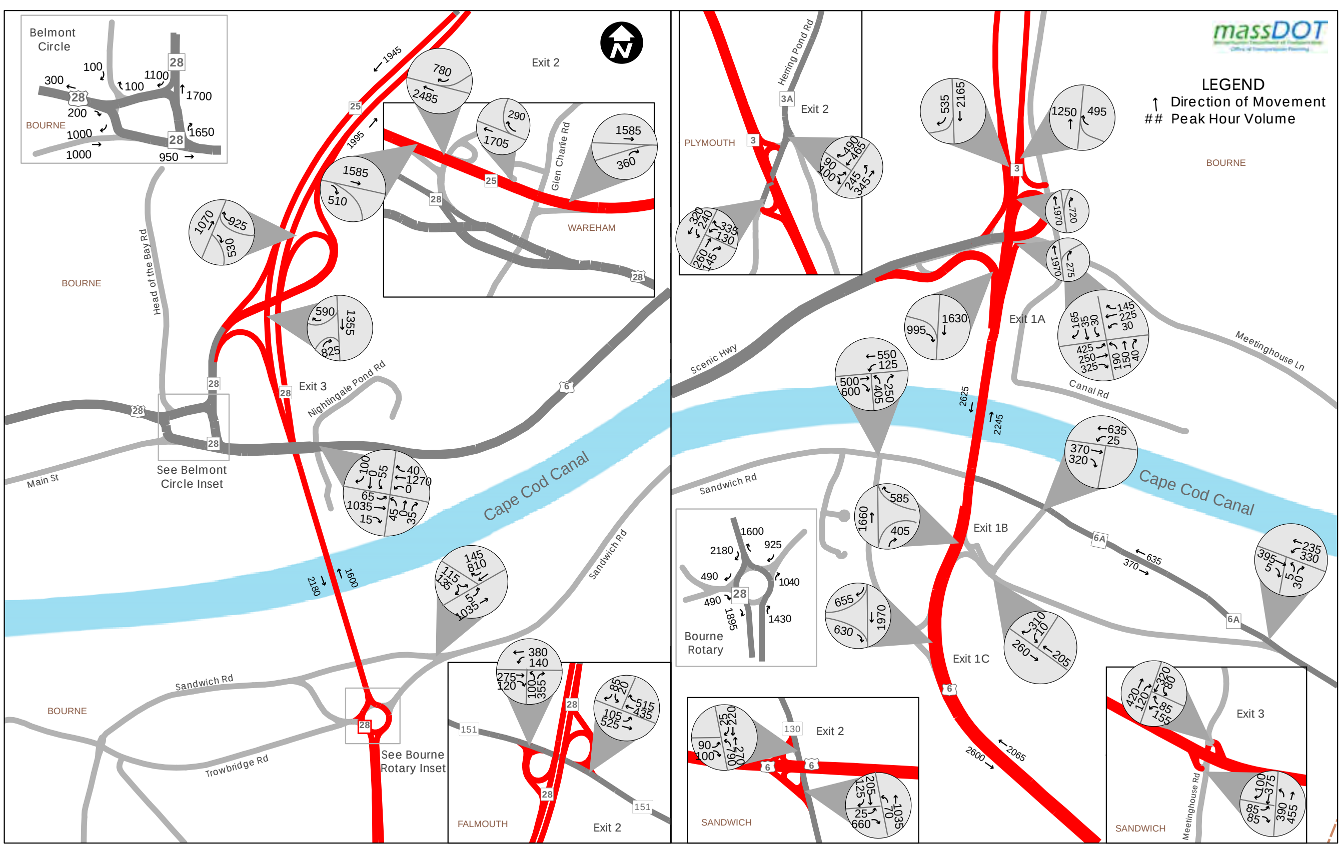
*Text continues on page 3-12.*

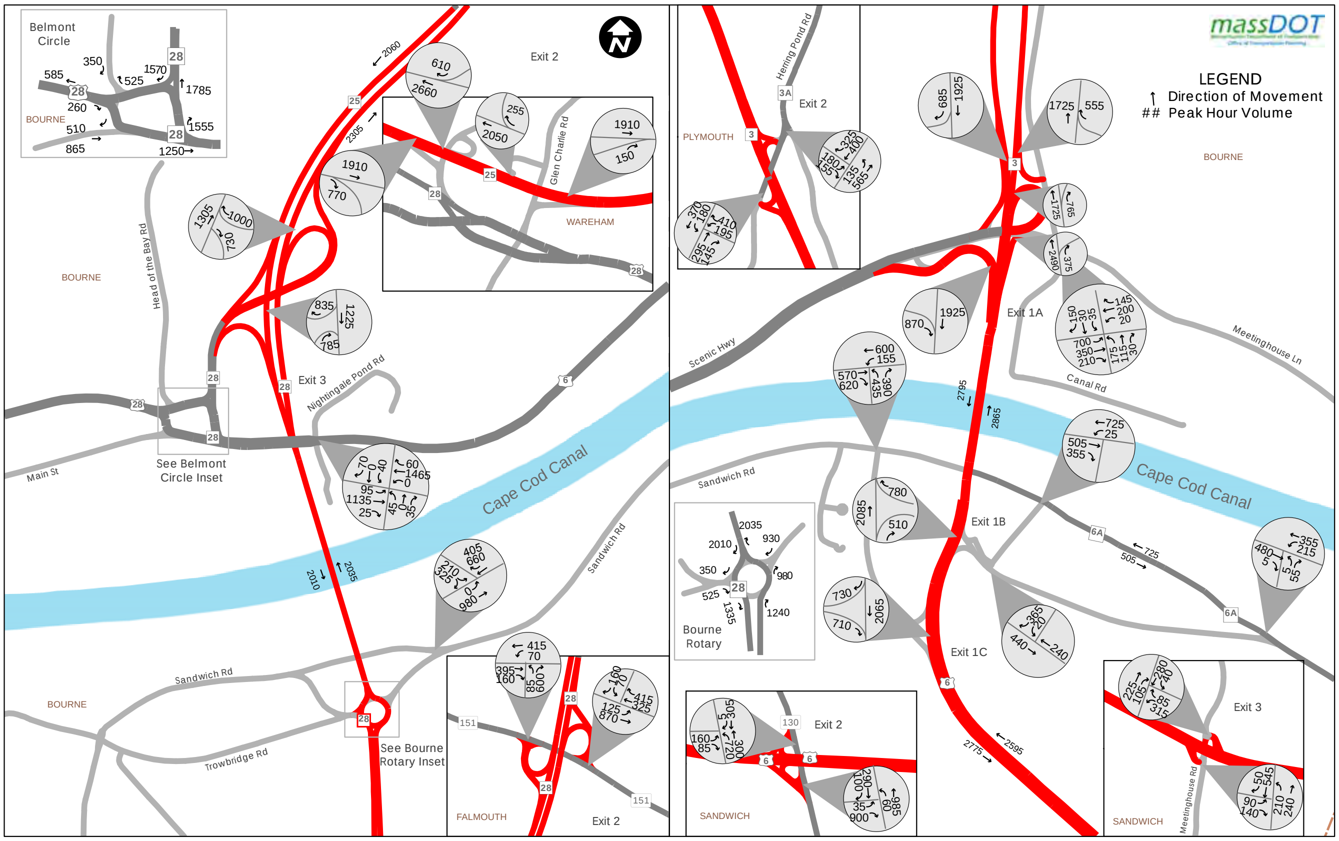
Table 3-2 Growth in Average Daily Traffic (ADT) at Key Locations 2014 - 2040

| ATR COUNTING STATIONS | EXISTING (2014) | | FUTURE (2040) | | PROJECTED GROWTH | |
|---|---|---|---|---|---|---|
| | SUMMER ADT[1] | NON-SUMMER ADT[1] | SUMMER ADT[1] | NON-SUMMER ADT[1] | SUMMER ADT[1] | NON-SUMMER ADT[1] |
| Bourne Bridge | 56,500 | 38,000 | 61,600 | 45,200 | 9% | 19% |
| Sagamore Bridge | 65,900 | 41,400 | 93,300 | 59,600 | 42% | 44% |
| Route 3 between Exits 1A and 2 | 51,600 | 29,900 | 72,400 | 51,800 | 40% | 73% |
| Route 6 between Exits 1 and 2 | 72,300 | 39,600 | 90,600 | 51,800 | 25% | 31% |
| Route 25 West of Exit 2 | 62,900 | 42,900 | 78,900 | 56,800 | 25% | 32% |
| Route 25 East of Exit 2 | 24,500 | 16,900 | 26,200 | 19,700 | 7% | 17% |
| Route 6 (Scenic Hwy) East of Nightingale Rd | 33,600 | 21,000 | 36,200 | 25,400 | 8% | 21% |
| Sandwich Rd East of Bourne Rotary Connector | 30,800 | 22,600 | 33,400 | 28,100 | 8% | 24% |
| Adams St South of Sandwich Rd | 7,600 | 7,600 | 11,800 | 13,900 | 55% | 83% |
| Buzzards Bay Bypass | 7,900 | 6,000 | 8,800 | 6,000 | 11% | 0% |
| Main St West of Perry Ave | 25,600 | 11,900 | 28,500 | 12,120 | 11% | 2% |
| Trowbridge Rd West of Veterans Way | 7300 | 6,300 | 11,500 | 9,900 | 58% | 57% |
| Route 28 South of Bourne Rotary | 42,500 | 34,800 | 49,000 | 40,100 | 15% | 15% |
| Route 130 North of Route 6 | 12,200 | 9,300 | 12,500 | 13,200 | 2% | 42% |
| Route 6 between Exit 2 and 3 | 56,400 | 41,600 | 67,000 | 56,000 | 19% | 35% |
| Mid-Cape Connector South of Sandwich Rd | 19,100 | 15,300 | 28,500 | 18,100 | 49% | 18% |
| Route 6 East of Exit 3 | 57,000 | 44,900 | 70,900 | 53,400 | 24% | 19% |
| State Rd North of Ramp to Route 3 NB | 5,700 | 4,700 | 8,200 | 6,200 | 44% | 32% |
| Route 6A East of Cranberry Hwy | 12,400 | 7,500 | 15,100 | 8,300 | 22% | 11% |
| Route 3 between Exits 2 and 3 | 44,600 | 37,400 | 60,000 | 50,300 | 35% | 35% |

[1]Average Daily Traffic (ADT)

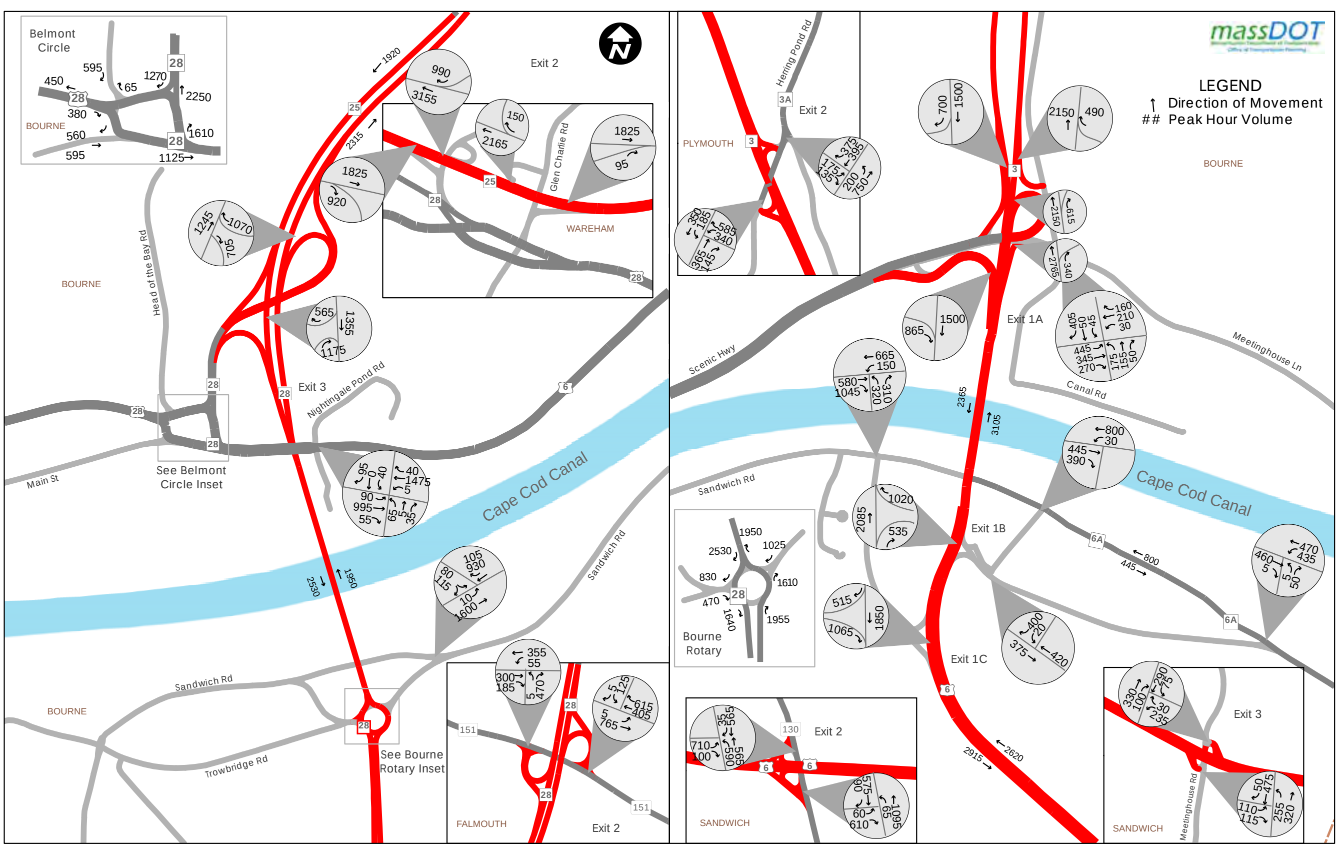
**Exhibit 3-4 Future (2040) Non-Summer Weekday AM Turning Movements**






## Exhibit 3-5 Future (2040) Non-Summer Weekday PM Turning Movements

## Exhibit 3-6 Future (2040) Non-Summer Saturday Turning Movements



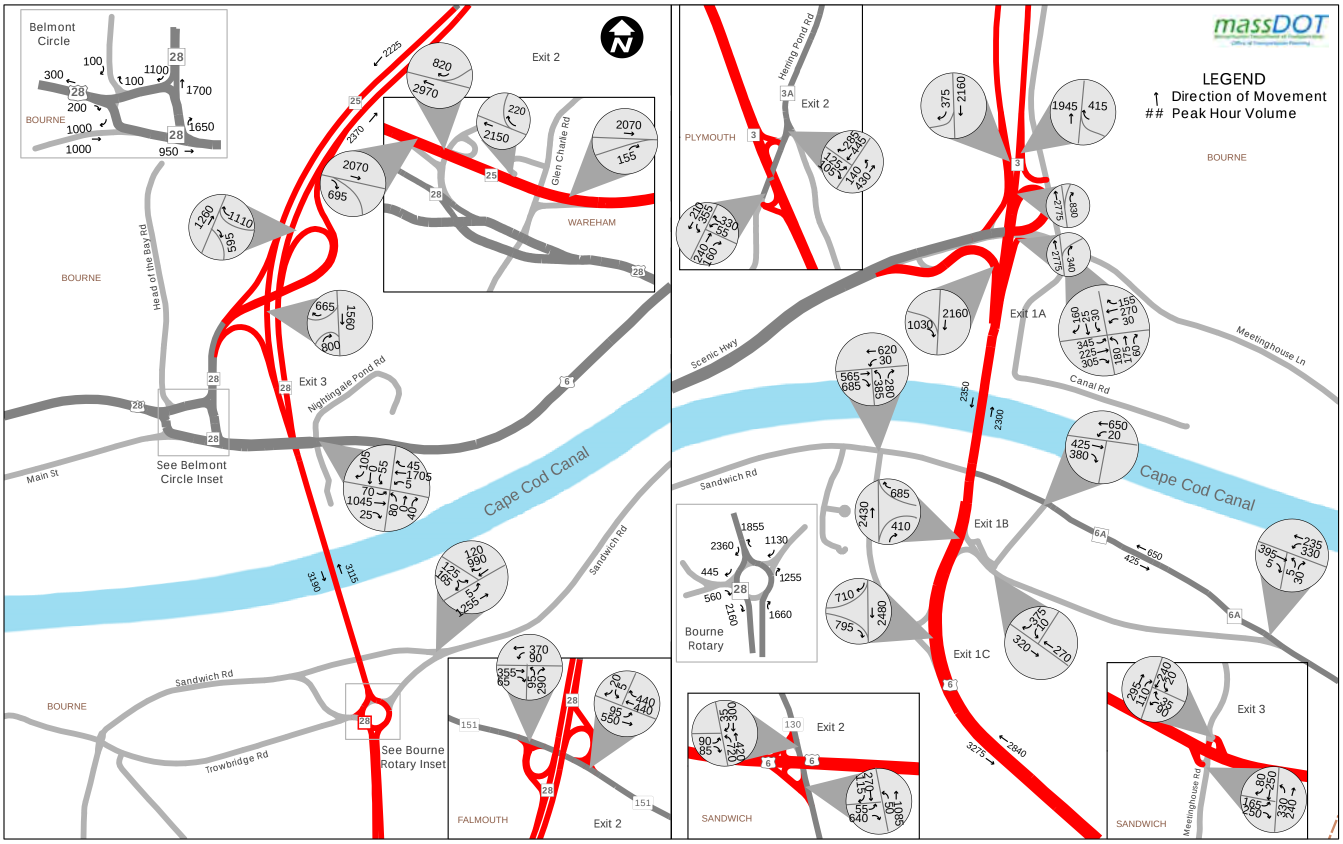
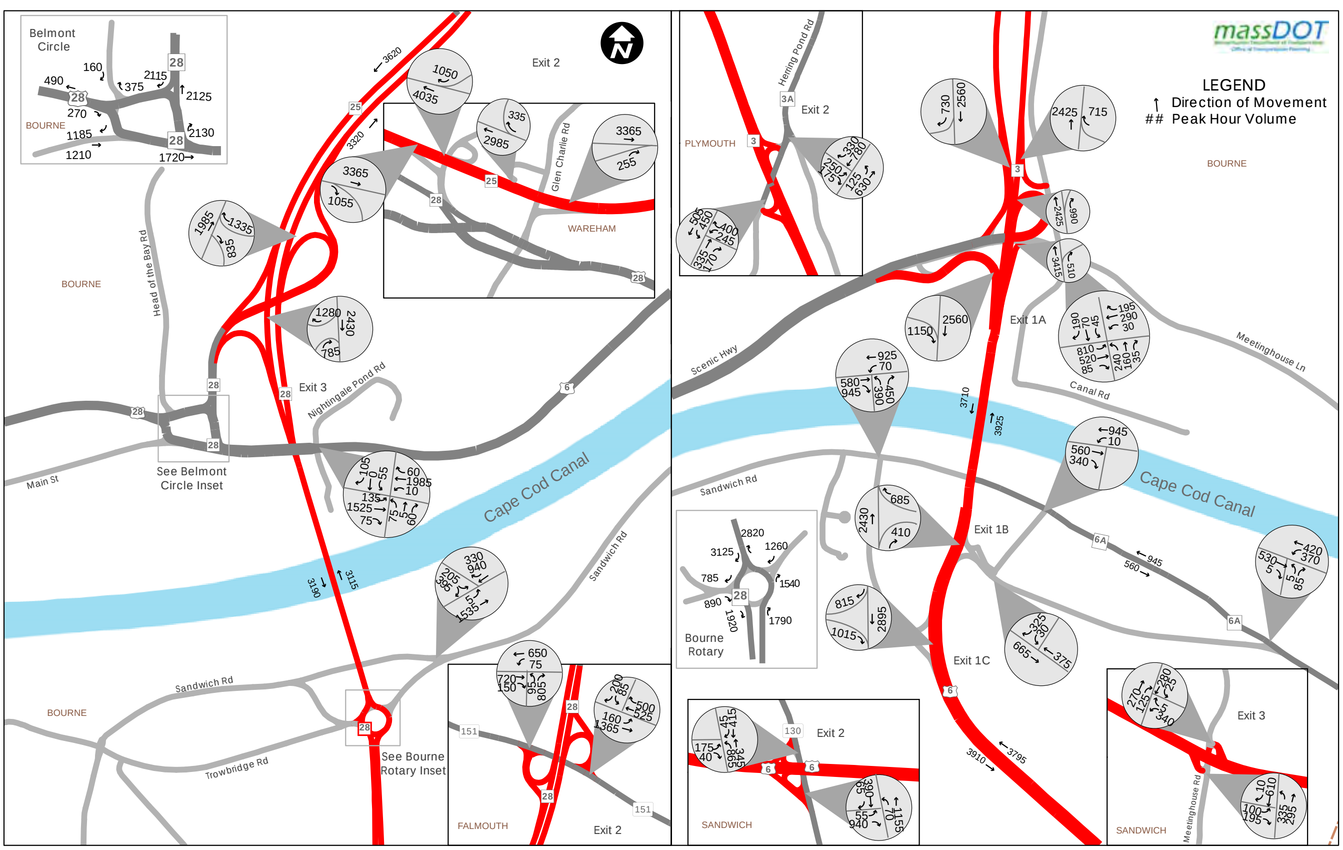



**Exhibit 3-7 Future (2040) Summer Weekday AM Turning Movements**

**Exhibit 3-8 Future (2040) Summer Weekday PM Turning Movements**



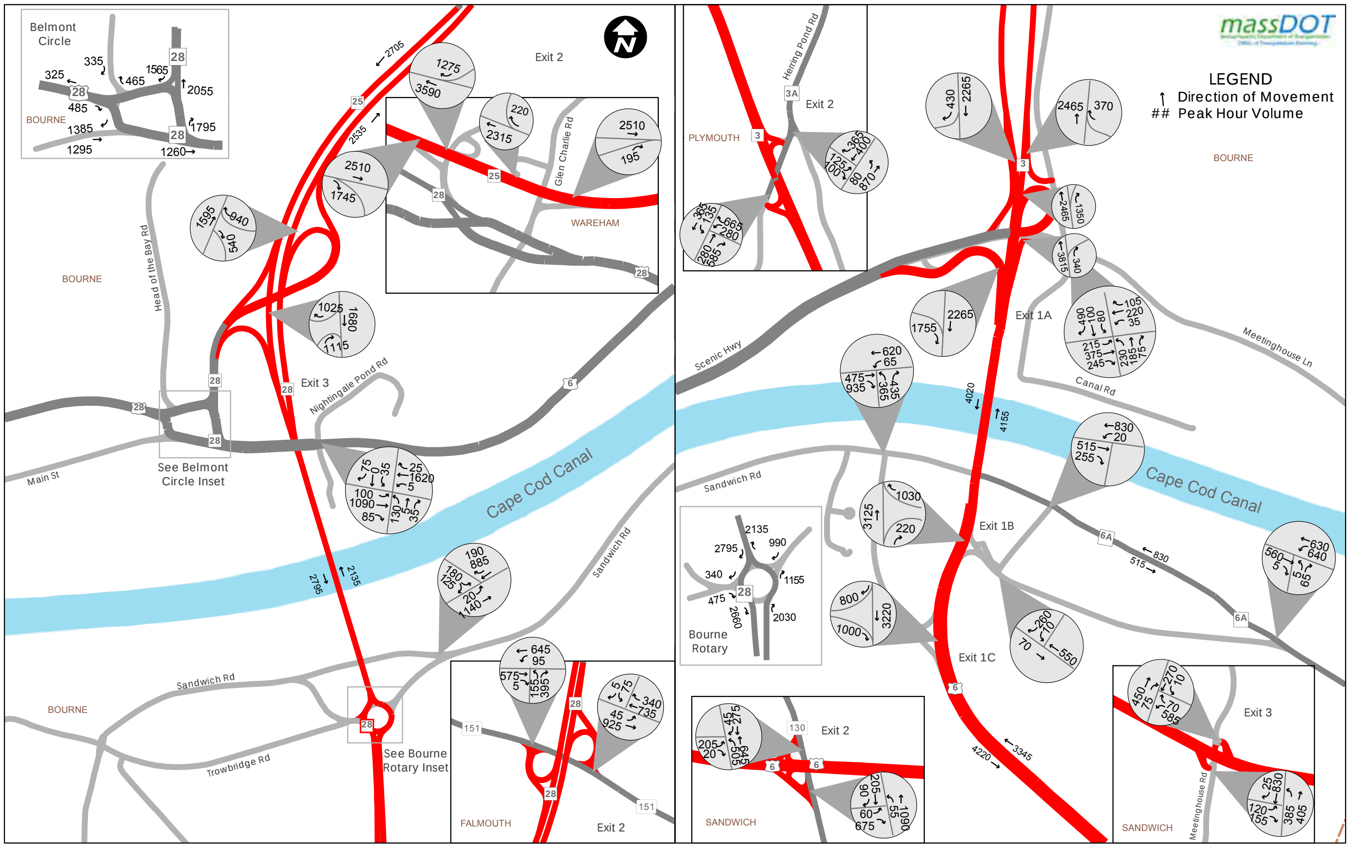



*Exhibit 3-9* *Future (2040) Summer Saturday Turning Movements*

## 3.3.6 Future (2040) No-Build Levels of Service

Based on the future (2040) forecast traffic volumes, LOS were analyzed at 60 locations throughout the study area, including signalized and unsignalized intersections, highway links, and highway ramps. As with other data, LOS was calculated for the AM and PM weekday peak-periods and Saturday mid-day peak periods. The time periods examined were:

- AM summer weekday (7:00 AM – 9:00 AM)
- PM summer weekday (4:00 PM – 6:00 PM)
- Saturday summer (10:00 AM –12:00 PM)
- AM non-summer weekday (7:00 AM – 9:00 AM)
- PM non-summer weekday (4:00 PM – 6:00 PM)
- Saturday non-summer (10:00 AM –12:00 PM)

The methodology for determining LOS is provided in Section 2.5.8. This same methodology is used to forecast future LOS. The LOS for the existing conditions is also provided in Section 2.5.8. The results of the future no-build analysis for LOS appear in Tables 3-3 and 3-4. Exhibits 3-10 and 3-11 (freeways) and Exhibits 3-12 through 3-17 (intersections) present the results graphically.

*Text continues on page 3-19.*

Table 3-3 *Future (2040) No-Build Levels of Service for Freeway Sections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER SATURDAY | NON-SUMMER SATURDAY |
|---|---|---|---|---|---|---|
| **HIGHWAY LINKS** | | | | | | |
| Bourne Bridge (NB) | C | B | D | C | C | C |
| Bourne Bridge (SB) | C | C | D | C | D | C |
| Route 25 East of Exit 2 (EB) | B | A | C | A | B | A |
| Route 25 East of Exit 2 (WB) | B | A | B | B | B | B |
| Route 25 West of Exit 2 (EB) | B | A | C | B | C | B |
| Route 25 West of Exit 2 (WB) | B | B | C | B | C | B |
| Route 3 Between Exits 1A and 2 (NB) | C | B | D | C | C | C |
| Route 3 Between Exits 1A and 2 (SB) | C | C | D | C | C | C |
| Route 6 EB Between Exits 1 and 2 (EB) | D | C | **E** | C | **E** | D |
| Route 6 WB Between Exits 1 and 2 (WB) | D | C | **E** | C | D | C |
| Sagamore Bridge (NB) | D | C | **E** | D | **E** | D |
| Sagamore Bridge (SB) | D | C | D | D | **E** | C |
| **HIGHWAY ON-RAMPS** | | | | | | |
| Belmont Circle to Route 25 WB | B | B | B | B | B | B |
| Cranberry Highway to Route 6 WB (Exit 1C) | D | C | **E** | D | **E** | D |
| Route 130 to Route 6 EB | C | C | D | B | **E** | C |
| Glen Charlie to Route 25 EB | B | B | C | B | B | B |
| Route 130 to Route 6 WB | D | C | **E** | C | D | C |
| Quaker Meeting House Rd to Route 6 EB | C | C | D | C | **E** | C |
| Herring Pond Road to Route 3 NB | C | C | D | C | D | C |
| Herring Pond Road to Route 3 SB | C | C | D | B | C | C |
| Mid Cape Connector to Route 6 EB | D | C | **E** | C | **E** | D |
| Quaker Meeting House Road to Route 6 WB | C | B | D | C | D | C |
| Scenic Hwy to Route 6 EB/Bridge | D | C | **E** | D | **E** | C |
| Belmont Circle to Route 25 EB (Bourne Bridge) | C | C | D | B | D | C |
| **HIGHWAY OFF-RAMPS** | | | | | | |
| Route 25 EB to Maple Springs Rd | B | B | C | B | C | B |
| Route 6 EB to Route 130 | **E** | C | **E** | D | **E** | D |
| Route 6 WB to Route 130 | C | B | D | C | D | D |
| Route 6 EB to Mid-Cape Connector | D | D | **E** | D | **E** | C |
| Route 6 EB to Quaker Meeting House Rd | D | C | D | C | **E** | C |
| Route 6 WB to Quaker Meetinghouse Rd | C | B | D | C | **E** | D |
| Route 6 WB (Exit 1) to Cranberry Hwy | D | C | **E** | D | **E** | D |
| Route 25 EB to Belmont Circle | B | B | C | B | B | B |
| Route 3 NB to Herring Pond Rd | C | B | D | C | D | C |
| Route 3 SB to Herring Pond Rd | C | C | D | D | D | D |

*LOS E or LOS F locations are* **bold**

*Table 3-3 continues on the next page.*

*Table 3-3 Future (2040) No-Build Levels of Service for Freeway Sections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER SATURDAY | NON-SUMMER SATURDAY |
|---|---|---|---|---|---|---|
| Bourne Bridge to Belmont Circle | B | A | B | B | B | B |
| Route 3 SB to Scenic Hwy | C | C | **E** | D | D | C |
| Route 6 WB (Sagamore Bridge NB) to 6 WB/Scenic Hwy | D | C | **E** | C | **E** | D |
| Route 6 WB (Sagamore Bridge NB) to Meeting House Rd | D | C | **E** | D | **E** | D |

*LOS E or LOS F locations are* ***bold***

*Table 3-4 Future (2040) No-Build Levels of Service at Select Intersections*

| | SUMMER AM | NON-SUMMER AM | SUMMER PM | NON-SUMMER PM | SUMMER SATURDAY | NON-SUMMER SATURDAY |
|---|---|---|---|---|---|---|
| SIGNALIZED INTERSECTIONS | | | | | | |
| Scenic Hwy at Church Lane | C | C | C | B | D | C |
| Meetinghouse Lane, State Rd and Canal Rd | D | D | **F** | **F** | C | D |
| Scenic Highway at Nightingale Pond Rd/Andy Olivia Drive | B | A | **F** | B | D | B |
| Route 6 EB Off Ramp (Exit 2) at Route 130 | C | C | **F** | **F** | C | **F** |
| UNSIGNALIZED INTERSECTIONS (FOR MINOR ROAD APPROACH) | | | | | | |
| Sandwich Rd at Bourne Rotary Connector | **F** | **F** | **F** | **F** | **F** | **F** |
| Sandwich Rd at High School Drive | **F** | **F** | **F** | **F** | **F** | **F** |
| Sandwich Rd at Harbor Lights Rd | **F** | **F** | **F** | **F** | **F** | **F** |
| Sandwich Rd at Jarvis Drive | D | **F** | A | **F** | A | **E** |
| County Road, Sandwich Road, & Trowbridge Road | **E** | D | **F** | **F** | C | **E** |
| Route 28 NB Off-ramp at Route 151 | C | D | **F** | **F** | **F** | D |
| Route 28 SB Off-ramp at Route 151 | D | D | **F** | **F** | **F** | C |
| Sandwich Rd, Cranberry Hwy, and Regency Drive | **F** | D | **E** | **E** | **F** | C |
| Old Kings Hwy at Main Street | B | B | C | C | **F** | D |
| Route 6A at Route 130 (Main Street) / Tupper Road | **F** | D | C | F | **F** | **F** |
| Maple Springs Rd at Route 25 EB | C | B | **F** | D | **F** | **F** |
| Route 130 at Cotuit Rd | **F** | **F** | **F** | **F** | **F** | **F** |
| Herring Pond Rd at State Road | **E** | **F** | **F** | **F** | **F** | **F** |
| Belmont Circle | **F** | **F** | **F** | **F** | **F** | **F** |
| Bourne Rotary | **F** | **F** | **F** | **F** | **F** | **F** |
| Route 6 EB Off Ramp (Exit 3) Quaker Meeting House Rd | **F** | **F** | **F** | **F** | **F** | **F** |
| Route 3 SB Off Ramp at Exit 2/Herring Pond Rd | **E** | **F** | **F** | **F** | **F** | **F** |
| Route 130 (Main St) at Tupper Rd | B | B | D | B | D | C |

*LOS E or LOS F locations are* ***bold***

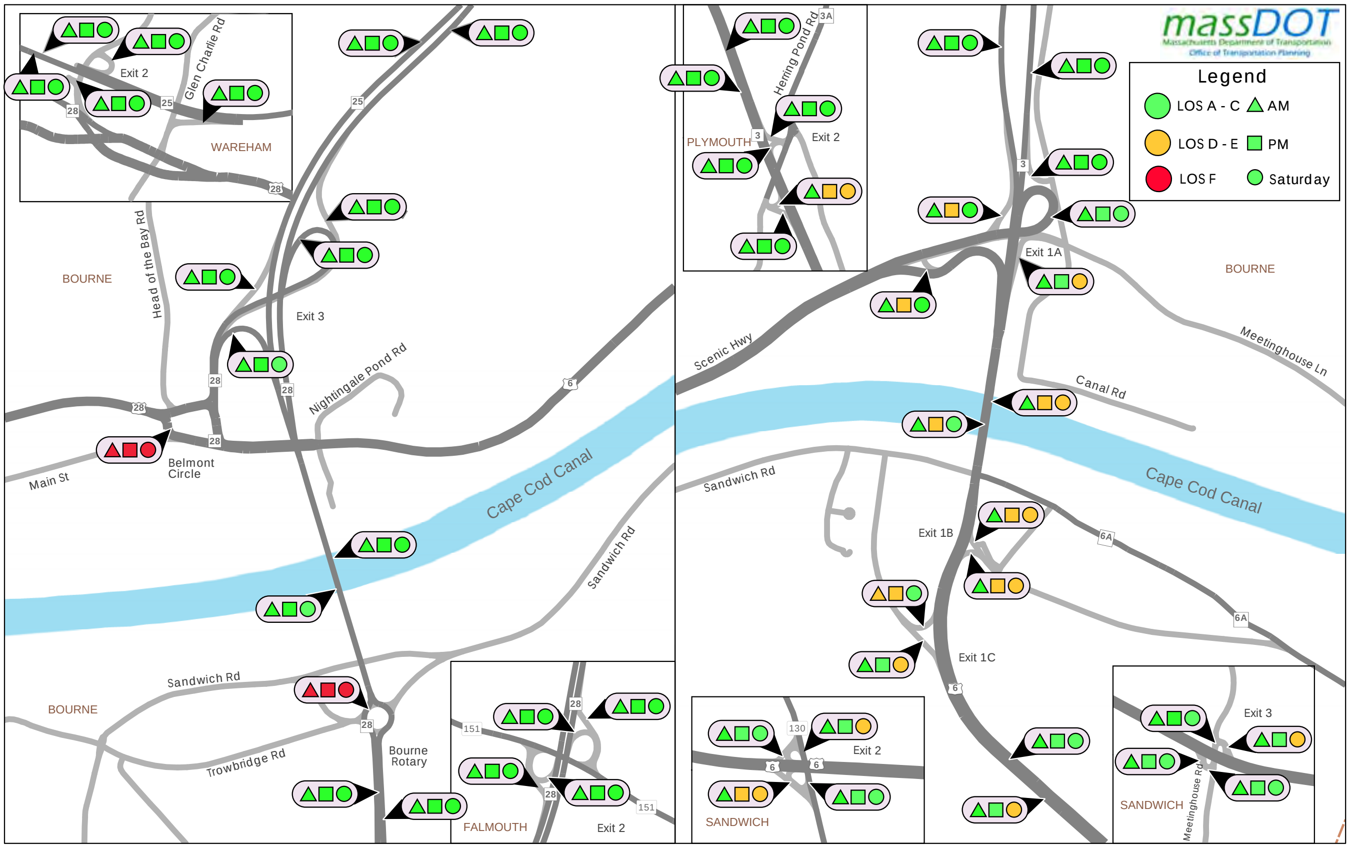
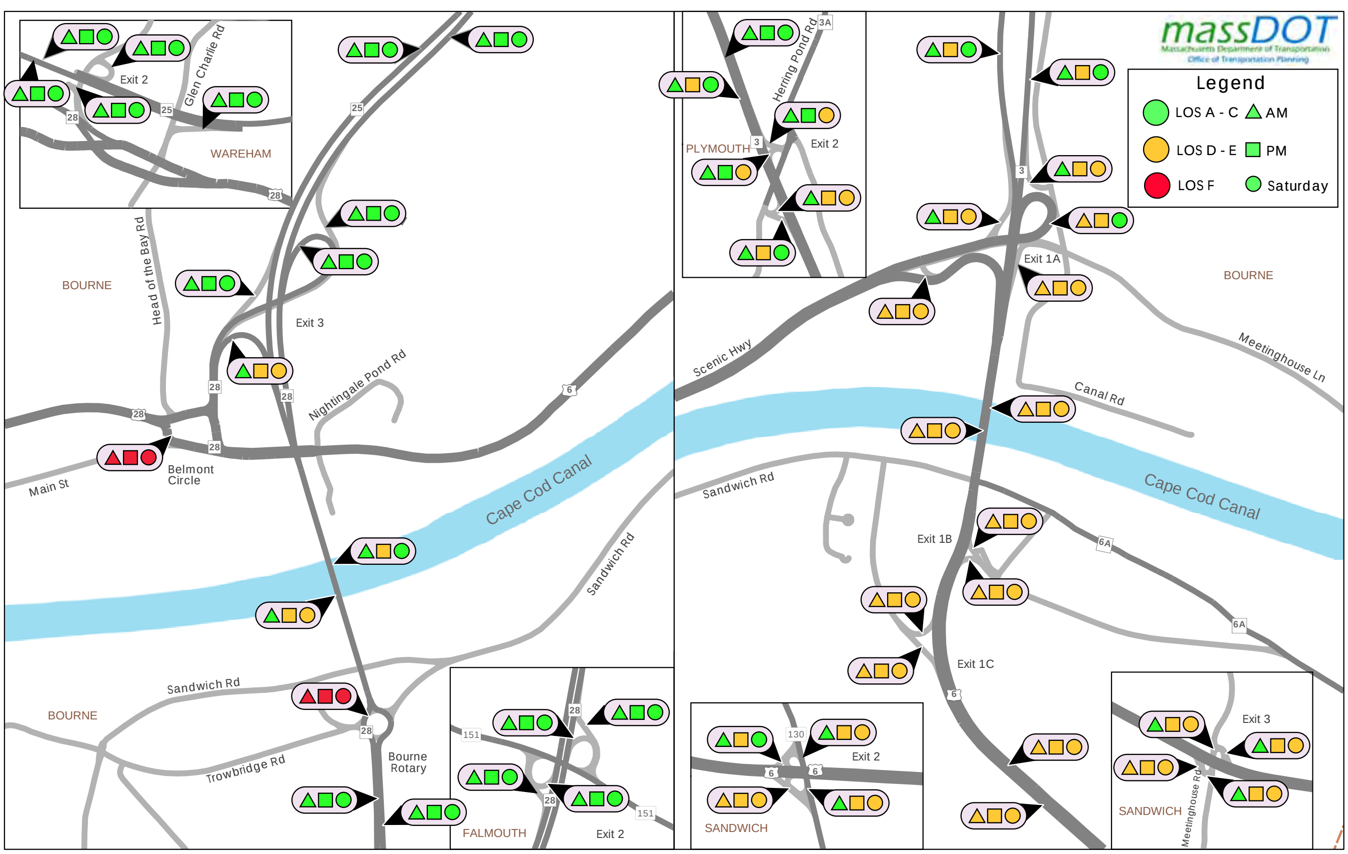



*Exhibit 3-10 Future (2040) No-Build Non-Summer Levels of Service - AM/PM/Saturday (Freeway)*

*Exhibit 3-11 Future (2040) No-Build Summer Levels of Service - AM/PM/Saturday (Freeway)*



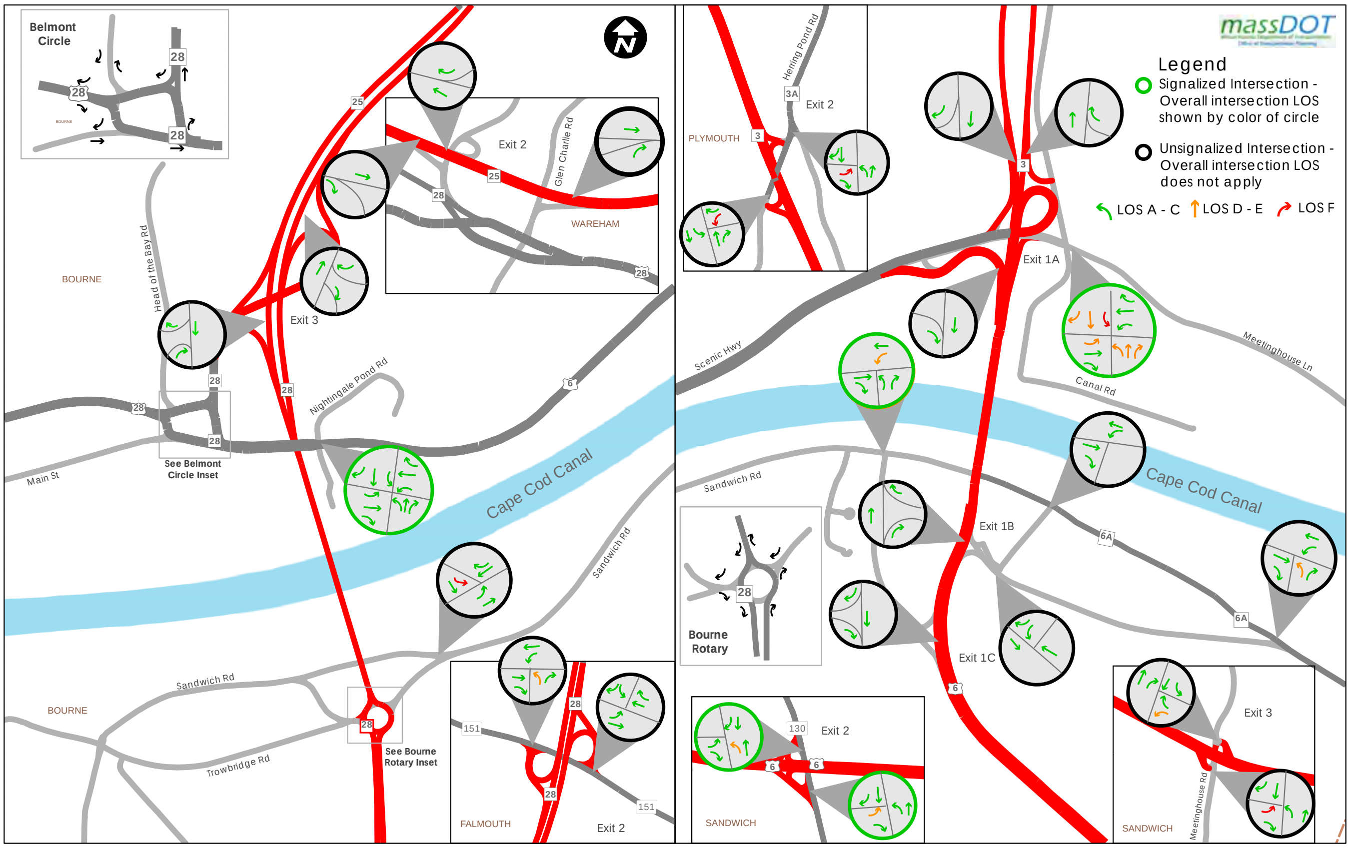
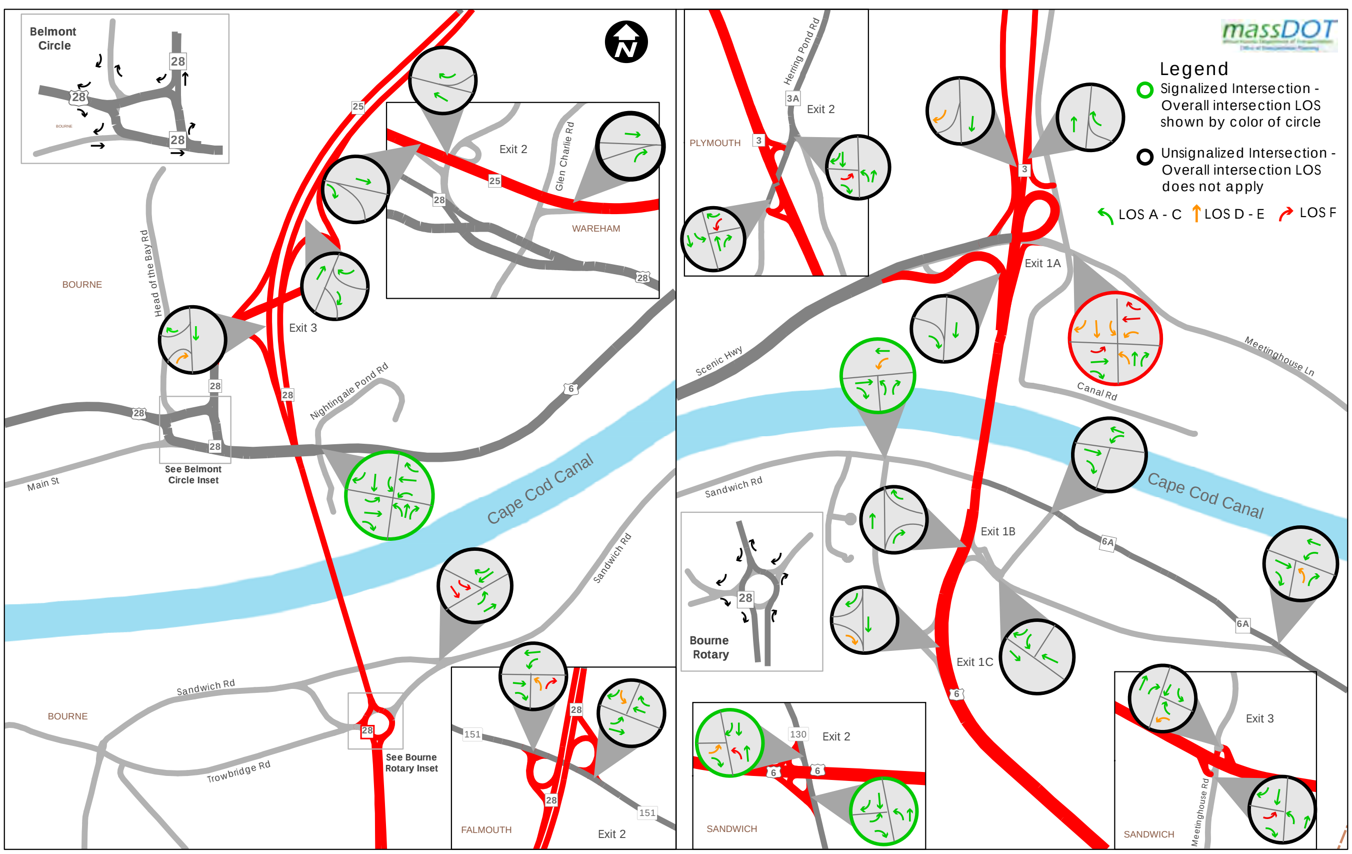



*Exhibit 3-12 Future (2040) No-Build Non-Summer Weekday AM Levels of Service (Intersections)*

*Exhibit 3-13 Future (2040) Non-Build Non-Summer Weekday PM Levels of Service (Intersections)*



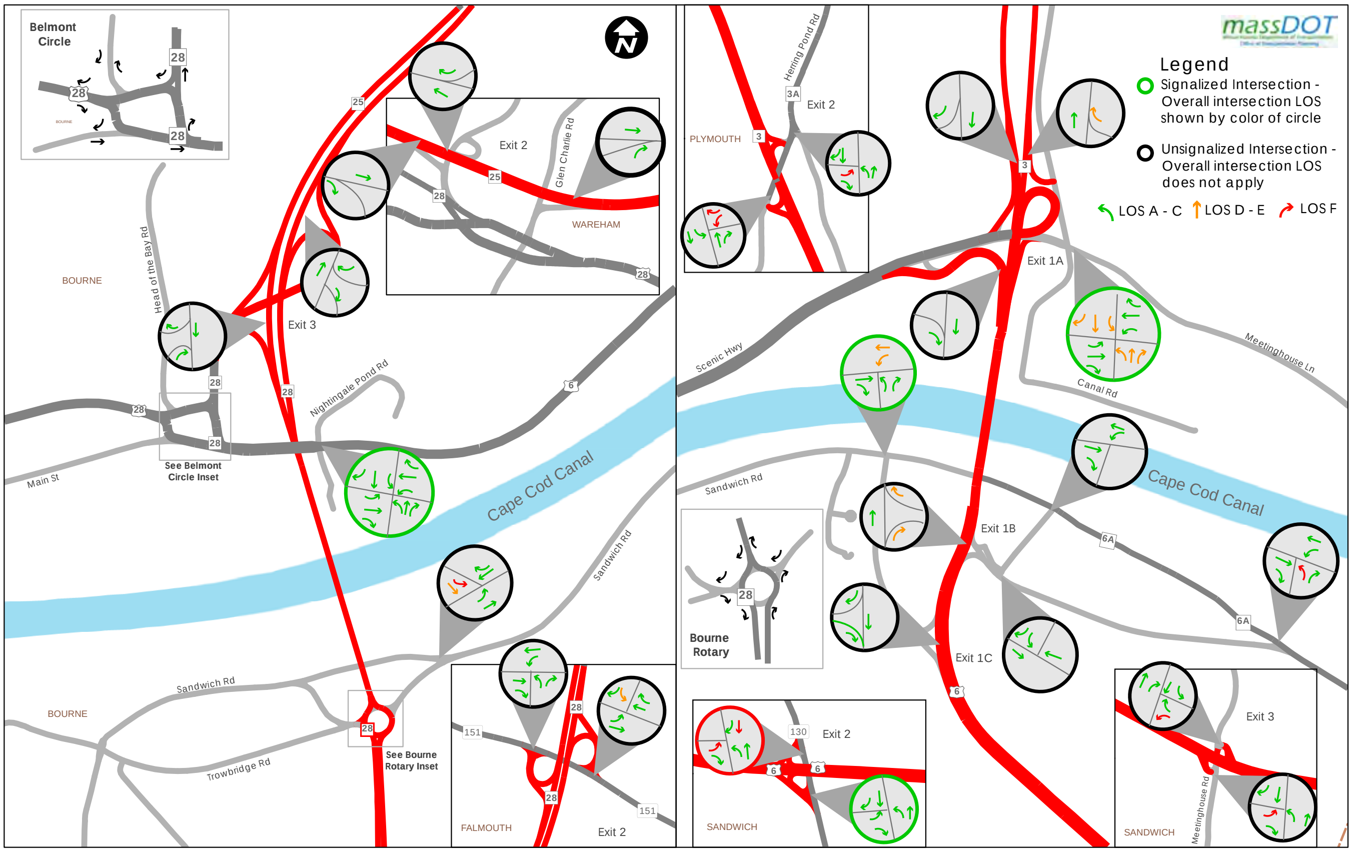
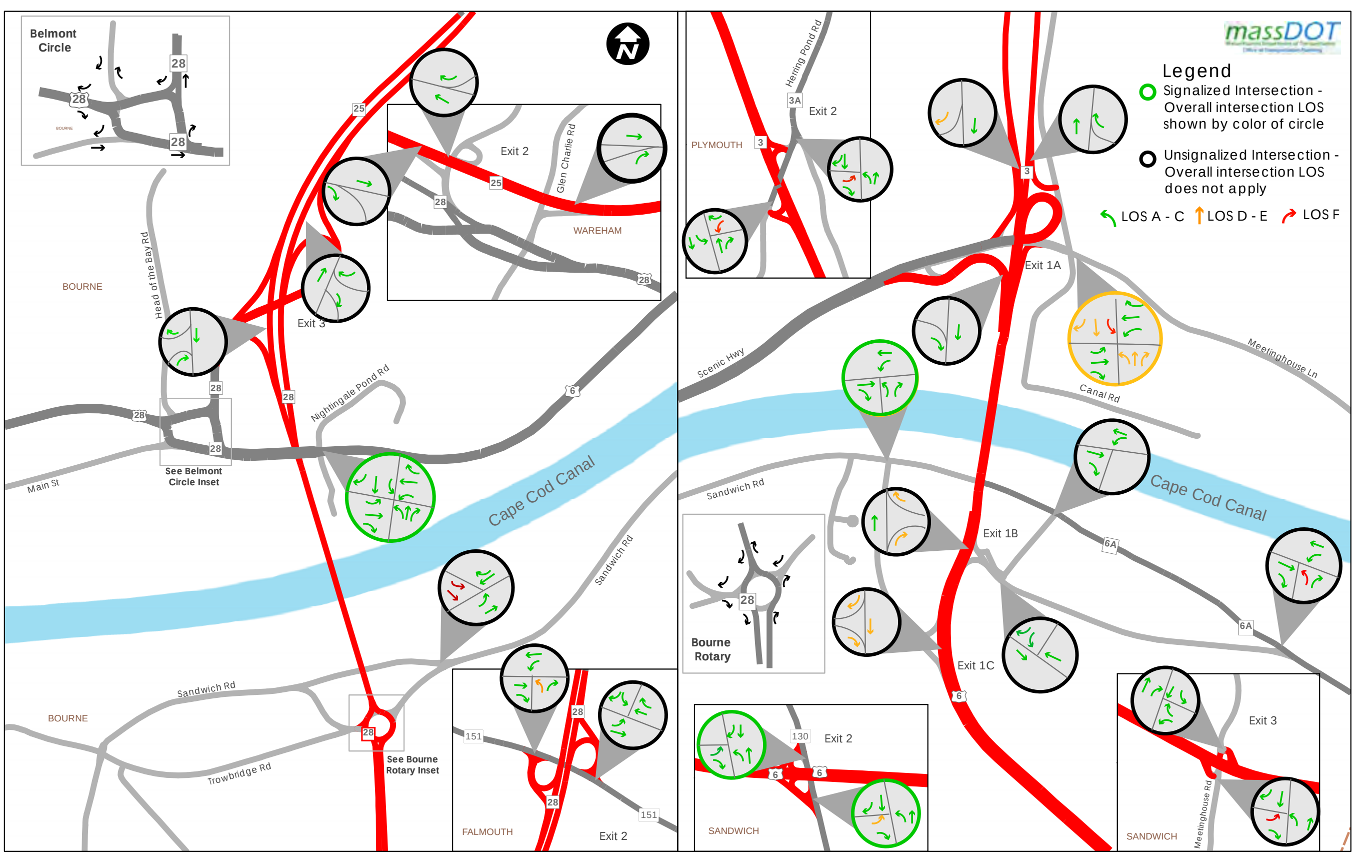



***Exhibit 3-15 Future (2040) No-Build Non-Summer Saturday Levels of Service (Intersections)***

***Exhibit 3-14 Future (2040) No-Build Summer Weekday AM Levels of Service (Intersections)***



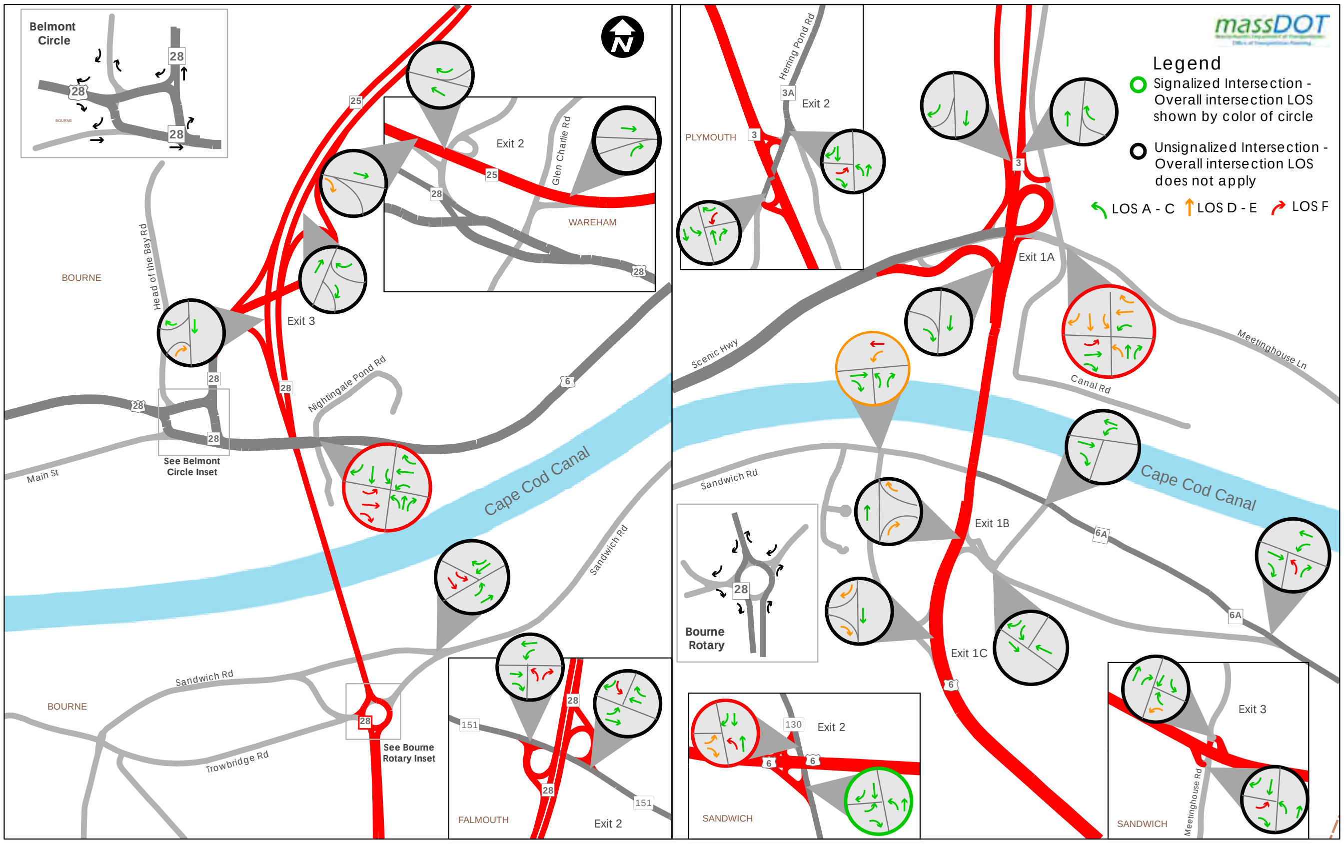
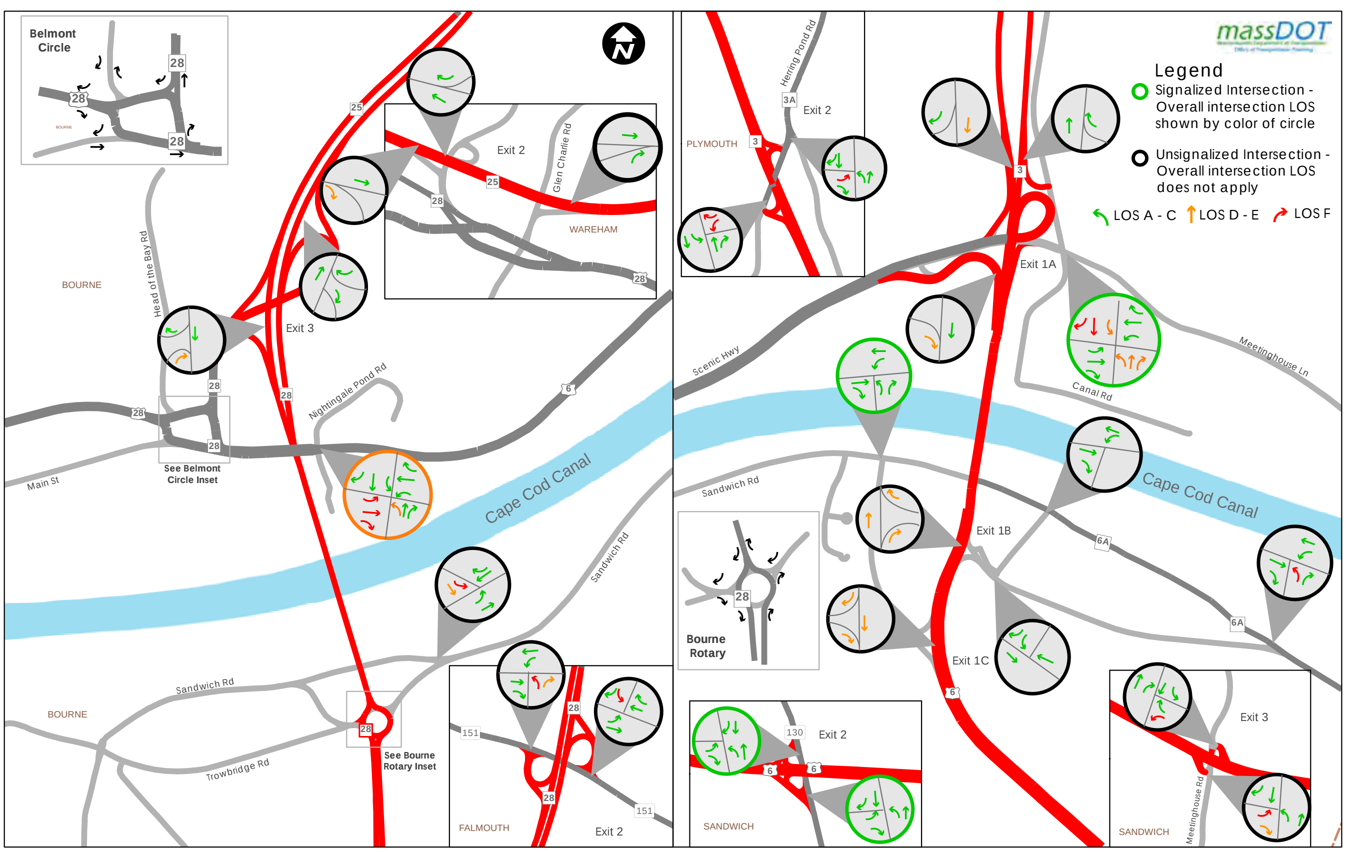



*Exhibit 3-16 Future (2040) No-Build Summer Weekday PM Levels of Service (Intersections)*

*Exhibit 3-17 Future (2040) No-Build Summer Saturday Levels of Service (Intersections)*



The following presents a summary of traffic operations (in terms of LOS) for both the existing and future no-build conditions.

### *Summary of Freeway Traffic Operations*

*Existing (2014) Conditions*

- Generally acceptable traffic operations (LOS A – C) during most non-summer and summer periods along the mainline and interchanges of Route 3, Route 6, and Route 25.
- Less acceptable traffic operations (LOS D) on the Sagamore Bridge and the Route 6 approach to the Sagamore Bridge during summer periods.
- Less acceptable traffic operations (LOS D) during the summer periods at several Route 6 interchanges, including Exit 1C (Cranberry Highway), Exit 2 (Route 130), and Exit 3 (Quaker Meetinghouse Road).

*Future (2040) No-Build Conditions*

- Generally acceptable traffic operations (LOS A – C) during all non-summer periods along the mainline and interchanges of Route 3, Route 6, and Route 25.
- Substantially more freeway and interchange locations operating at less acceptable levels (LOS D/E) during the summer periods (compared to the existing condition), particularly at the Bourne and Sagamore Bridges, and adjacent interchanges.

### *Summary of Intersection Traffic Operations*

*Existing (2014) Conditions*

- Numerous intersections with poor traffic operations (LOS E/F), especially during summer periods.
- Worst performing intersections (LOS E/F during all time periods) include:
- Belmont Circle
- Bourne Rotary
- Sandwich Road at Bourne Rotary Connector
- Sandwich Road at High School Drive
- Sandwich Road at Harbor Lights Drive
- Route 130 at Cotuit Road

*Future (2040) No-Build Conditions*

- Numerous intersections with poor traffic operations (LOS E/F), especially during summer periods. Compared to the

existing conditions, degraded traffic conditions occur at intersections throughout the study area.

- The most congested intersections (LOS E/F during all time periods) include those identified for the existing conditions plus three additional locations:
- Belmont Circle
- Bourne Rotary
- Sandwich Road at Bourne Rotary Connector
- Sandwich Road at High School Drive
- Sandwich Road at Harbor Lights Drive
- Route 130 at Cotuit Road
- Herring Pond Road at State Road
- Route 3 SB Off-Ramp at Exit 2/Herring Pond Road
- Route 6 EB Off-Ramp (Exit 3) at Quaker Meeting House Lane

### 3.3.7 Traffic Operations at Belmont Circle and Bourne Rotary

As noted in Section 2.5.10, Belmont Circle and the Bourne Rotary have a considerable impact on regional travel patterns and traffic operations. The high frequency of cross-corridor travel often results in traffic volumes that exceed the capacity of Belmont Circle and Bourne Rotary. This results in significant queues and delays at their approaches. Further, the proximity of these rotaries to each other can result in queues at one location negatively affecting traffic operations at the other. Both locations currently experience LOS F conditions during all peak periods in the summer and non summer.

Tables 3-5 and 3-6 and Exhibit 3-18 provide a comparison of vehicle delay and queue lengths for approaches to Belmont Circle and Bourne Rotary, respectively, for the existing (2014) and future (2040) non-summer weekday PM and summer Saturday peak periods.

#### *Belmont Circle*

The VISSIM™ analysis quantified vehicle delays and the queue length for the five approaches to Belmont Circle including Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the Route 25 ramps. As shown in Table 3-6 and Exhibit 3-18, the approaches with the greatest delay and queue lengths include those from Scenic Highway and Main Street to Belmont Circle.

The queues of note for the future no-build condition include the Scenic Highway (westbound) and the Main Street (eastbound)

*Table 3-5 Belmont Circle – Comparison of Existing (2014) and Future (2040) No-Build Queue Lengths and Average Delay*

| Street Name/ Approach | 2014 EXISTING | | | | 2040 FUTURE NO BUILD | | | |
|---|---|---|---|---|---|---|---|---|
| | Ave. Vehicle Delay (sec./min.) | | 95% Max. Queue Lengths (feet/miles) | | Ave. Vehicle Delay (sec./min.) | | 95% Max. Queue Lengths (feet/miles | |
| | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday |
| Route 25 Exit 3 Off-Ramps (WB) | 5 | **4** | 515 | 510 | 2 | 3 | 645 | **1,025** |
| Head of Bay Road (SB) | 15 | **83 (1.4)** | 270 | 570 | 317 (5.3) | 656 (10.9) | 1,780 | 2,700 (0.5) |
| Buzzards Bay Bypass (EB) | 3 | 19 | 100 | 335 | 3 | 11 | 110 | 305 |
| Main Street (EB) | 13 | **82 (1.4)** | 530 | **5,755 (1.1)** | 29 | **126 (2.1)** | **1,245** | **6,140 (1.2)** |
| Scenic Highway (WB) | 7 | **125 (2.1)** | 380 | **10,605 (2.0)** | 14 | **161 (2.7)** | **840** | **11,610 (2.2)** |

*Notes:*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles*
*Locations of excessive delay are* **bold**

*Table 3-6 Bourne Rotary – Comparison of Existing (2014) and Future (2040) No-Build Queue Lengths and Average Delay*

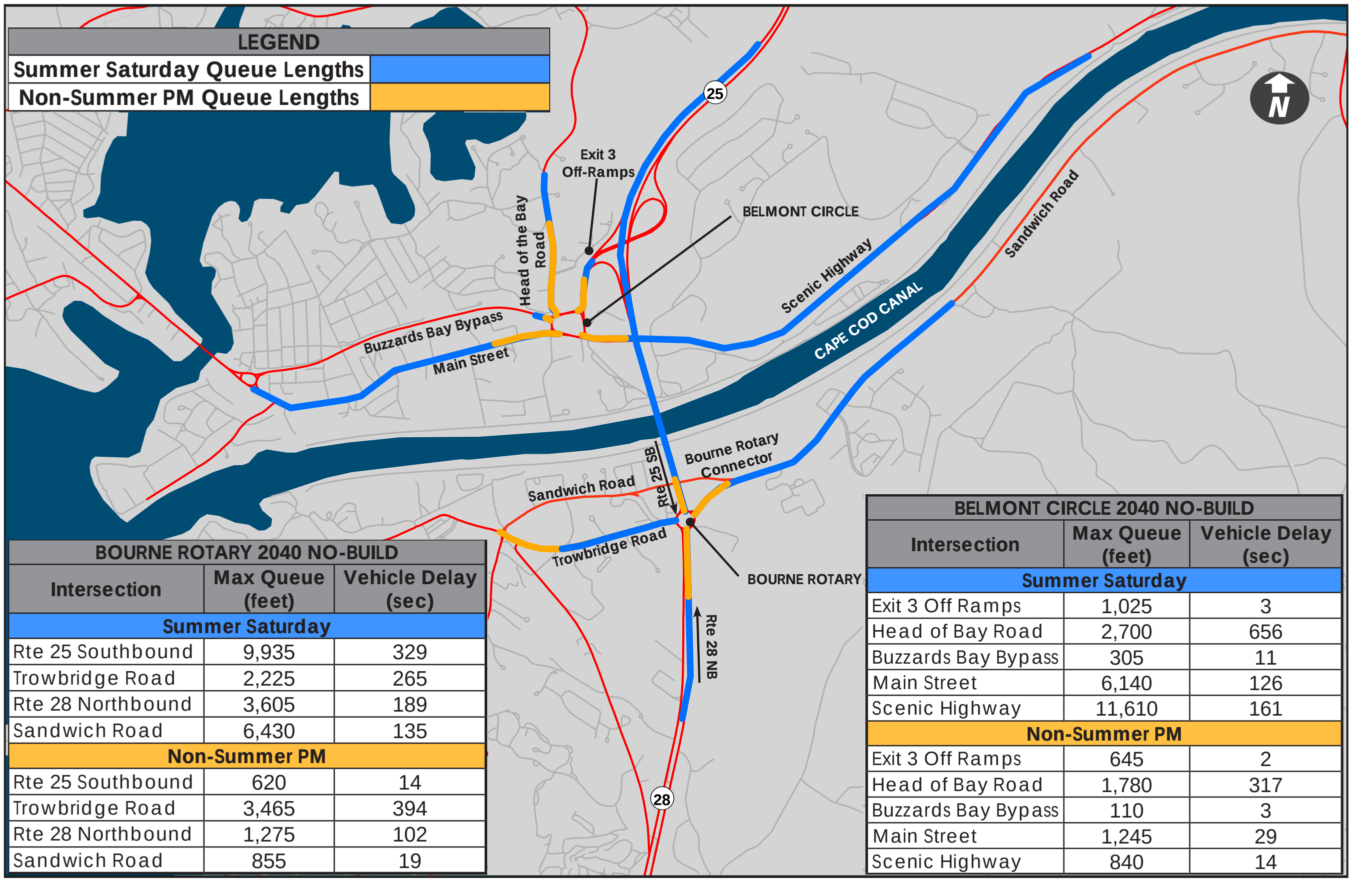
| STREET NAME/ APPROACH | 2014 EXISTING | | | | 2040 FUTURE NO BUILD | | | |
|---|---|---|---|---|---|---|---|---|
| | Ave. Vehicle Delay (sec./min.) | | 95% Max. Queue Lengths (feet/miles) | | Ave. Vehicle Delay (sec./min.) | | 95% Max. Queue Lengths (feet/miles | |
| | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday | Non-Summer PM | Summer Saturday |
| Route 25 (SB) | 19 | **280 (4.7)** | 650 | **8,885 (1.7)** | 14 | 329 (5.5) | 620 | **9,935 (1.9)** |
| Trowbridge Road (EB) | 75 (1.3) | 30 | 840 | 335 | **394 (6.6)** | **265 (4.4)** | **3,465 (0.7)** | **2,225** |
| Route 28 (NB) | 14 | **301 (5.0)** | 340 | **4,135 (0.8)** | **102 (1.7)** | **189 (3.2)** | **1,275** | **3,605 (0.7)** |
| Bourne Rotary Connector (WB) | 20 | 27 | 1,530 | 1,475 | 19 | 135 (2.3) | 855 | **6,430 (1.2)** |

*Notes:*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles*
*Locations of excessive delay are* **bold**

approach to Belmont Circle which can extend 6,140 to 11,610 feet (1.2 to 2.2 miles) during the summer Saturday peak periods, respectively. The queues on the Main Street (eastbound) approach to Belmont Circle can extend 1,245 feet during the non-summer weekday peak period.

### *Bourne Rotary*

The VISSIM™ analysis quantified vehicle delays and the queue length for the four approaches to Belmont Circle, including Route 28 (north and south approaches), Trowbridge Road, and Sandwich Road. As shown on Table 3-6 and Exhibit 3-18, the approaches with the greatest delay and queue lengths include those from Route 25 southbound and the Bourne Rotary Connector.




**BOURNE ROTARY 2040 NO-BUILD**

| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
|---|---|---|
| **Summer Saturday** | | |
| Rte 25 Southbound | 9,935 | 329 |
| Trowbridge Road | 2,225 | 265 |
| Rte 28 Northbound | 3,605 | 189 |
| Sandwich Road | 6,430 | 135 |
| **Non-Summer PM** | | |
| Rte 25 Southbound | 620 | 14 |
| Trowbridge Road | 3,465 | 394 |
| Rte 28 Northbound | 1,275 | 102 |
| Sandwich Road | 855 | 19 |

**BELMONT CIRCLE 2040 NO-BUILD**

| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
|---|---|---|
| **Summer Saturday** | | |
| Exit 3 Off Ramps | 1,025 | 3 |
| Head of Bay Road | 2,700 | 656 |
| Buzzards Bay Bypass | 305 | 11 |
| Main Street | 6,140 | 126 |
| Scenic Highway | 11,610 | 161 |
| **Non-Summer PM** | | |
| Exit 3 Off Ramps | 645 | 2 |
| Head of Bay Road | 1,780 | 317 |
| Buzzards Bay Bypass | 110 | 3 |
| Main Street | 1,245 | 29 |
| Scenic Highway | 840 | 14 |

***Exhibit 3-18 Belmont Circle and Bourne Rotary - Future (2040) No-Build Queue Lengths***

The queues of note for the future no-build condition include the Route 25 (southbound) and the Bourne Rotary Connector approach to the Bourne Rotary which can extend 9,935 and 6,430 feet (1.9 and 1.2 miles), respectively during the summer Saturday peak period. The queues on the Route 28 (northbound) approach to Bourne Rotary can extend 1,275 to 3,605 feet during the non-summer PM and summer Saturday peak periods, respectively.

## 3.4 PROBLEM INTERSECTIONS

The following section provides information on the 12 year-round problem intersections in the study area (Table 3-7). Problem intersections are defined as those that operated (or are forecast to operate) as an LOS E or F during at least one summer and non-summer peak period in 2014 or 2040. Problem intersections also include those intersections designated as high-crash locations under the Highway Safety Improvement Program (HSIP -described in greater detail in Section 2.5.11).

Roadway improvement alternatives will focus on these intersections. Particular attention was paid to problem intersections in the study area that experience the highest

Table 3-7 *Growth in Average Daily Traffic (ADT) at Key Locations 2014 - 2040*

| LOCATION NUMBER (EXHIBITS 3-21) | NAME OF LOCATION | TOWN | HSIP LOCATION (Y/N) | NON-SUMMER PM LOS 2040 FUTURE NO-BUILD | SUMMER SATURDAY LOS 2040 FUTURE NO-BUILD |
|---|---|---|---|---|---|
| 1 | Herring Pond Road at State Road | Plymouth | N | F | F |
| 2 | Belmont Circle | Bourne | Y | F | F |
| 3 | Scenic Highway at Nightingale Pond Road | Bourne | N | B | D |
| 4 | Bourne Rotary | Bourne | Y | F | F |
| 5 | Sandwich Road at Bourne Rotary Connector | Bourne | N | F | F |
| 6 | Sandwich Road at High School Drive | Bourne | Y | F | F |
| 7 | Sandwich Road at Harbor Lights Road | Bourne | N | F | F |
| 8 | Sandwich Road at Cranberry Highway/Regency Drive | Bourne | N | E | F |
| 9 | Route 6A at Route 130 (Main Street)/Tupper Road | Sandwich | Y | F | F |
| 10 | Scenic Highway/Meetinghouse Lane at State Road | Bourne | N | F | C |
| 11 | Route 130 at Cotuit Road | Sandwich | N | F | F |
| 12 | Route 28 Northbound Off/On Ramps at Route 151 (outside of study area) | Falmouth | N | E/F | F |

***Exhibit 3-19 Problem Intersections in the Study Area***

### *Exhibit 3-20 Photos of Problem Intersections*


| | |
|---|---|
| Intersection # | 1 |
| Roadways | Herring Pond Rd at State Rd |
| Town | Plymouth |
| Traffic Control | Yield |
| HSIP | No |


| | |
|---|---|
| Intersection # | 2 |
| Roadways | Belmont Circle |
| Town | Bourne |
| Traffic Control | Yield/Rotary |
| HSIP | Yes |


| | |
|---|---|
| Intersection # | 3 |
| Roadways | Scenic Hwy at Nightingale Pond Rd |
| Town | Bourne |
| Traffic Control | Signalized |
| HSIP | No |


| | |
|---|---|
| Intersection # | 4 |
| Roadways | Bourne Rotary |
| Town | Bourne |
| Traffic Control | Yield/Rotary |
| HSIP | Yes |


| | |
|---|---|
| Intersection # | 5 |
| Roadways | Sandwich Rd at Bourne Rotary Conn. |
| Town | Plymouth |
| Traffic Control | Yield |
| HSIP | No |


| | |
|---|---|
| Intersection # | 6 |
| Roadways | Sandwich Rd at High School Dr |
| Town | Bourne |
| Traffic Control | Flashing Yellow |
| HSIP | Yes |


| | |
|---|---|
| Intersection # | 7 |
| Roadways | Sandwich Rd at Harbor Lights Rd |
| Town | Bourne |
| Traffic Control | Unsignalized |
| HSIP | No |


| | |
|---|---|
| Intersection # | 8 |
| Roadways | Sandwich Rd at Cranberry Hwy |
| Town | Bourne |
| Traffic Control | Stop-Controlled |
| HSIP | No |


| | |
|---|---|
| Intersection # | 9 |
| Roadways | Route 6A at Route 130 |
| Town | Sandwich |
| Traffic Control | Stop-Controlled |
| HSIP | Yes |

*Figure 3-20 (continued) Photos of Problem Intersections*


| | |
|---|---|
| Intersection # | 10 |
| Roadways | Scenic Hwy at Meetinghouse Ln |
| Town | Bourne |
| Traffic Control | Signalized |
| HSIP | No |


| | |
|---|---|
| Intersection # | 11 |
| Roadways | Route 130 at Cotuit Road |
| Town | Sandwich |
| Traffic Control | Stop-Controlled |
| HSIP | No |


| | |
|---|---|
| Intersection # | 12 |
| Roadways | Route 28 at Route 151 On/Off Ramps |
| Town | Falmouth |
| Traffic Control | Yield-Control |
| HSIP | No |

travel volumes and associated congestion and delays. While not meeting the definition of a 'problem intersection', the Scenic Highway at Nightingale Pond Road intersection will be evaluated because of its proximity to, and effect on, Belmont Circle. The Route 6 Exit 1C interchange has also been evaluated because its location and substandard design contribute to congestion on Route 6 westbound, particularly during summer Sundays. The existing problem intersections are shown in Exhibits 3-19 and 3-20.

## 3.5 SUMMARY OF FUTURE NO-BUILD TRAFFIC CONDITIONS

As described in Chapters 2 and 3, traffic conditions along highways and at intersections in the study area, particularly in the immediate area of the Canal bridges, often suffer from severe congestion and delay. Several intersections have a history of high crash rates. While historically known to occur during the summer tourist season, this roadway congestion now often occurs during the spring and fall shoulder seasons.

The highest daily- and peak-period traffic volumes in the study area occur along the major highway corridors in the study area, including the Route 3/Sagamore Bridge/Route 6 corridor and the Route 25/Bourne Bridge/Route 28 corridor. Under existing conditions, average daily traffic (ADT) on the bridges is 30% to 40% higher in the summer compared to the non-summer peak period. Daily traffic volumes range from 56,000 to 65,000 vehicles in the summer and 38,000 to 41,000 in the non-summer periods, with the Sagamore Bridge generally having the higher traffic volumes. In the future, daily traffic crossing the Canal

bridges is forecast to increase by 30% in the summer and 22% in the non-summer period.

Currently, the levels of service (LOS) along the highways in the study area were generally found to be within the acceptable LOS A - C range. In the future, traffic operations are forecast to degrade, with substantially more freeway and interchange locations operating at less acceptable levels (LOS D/E) during the summer periods (compared to the existing condition), particularly at the Bourne and Sagamore Bridges, and adjacent interchanges.

The roads connecting the bridge approaches - Scenic Highway north of the Canal and Sandwich Road south of the Canal - also experience high traffic volumes and congestion. This is the result of high traffic volumes within the focus area (not just travel through the focus area) and vehicles traveling between the Route 25/Route 28 corridor and the Route 3/Route 6 corridor. This congestion is exacerbated by the inadequate capacity and substandard design at the intersections at the bridge approaches, especially Belmont Circle and Bourne Rotary (north and south of the Bourne Bridge) and Route 6 Exit 1C south of the Sagamore Bridge. The former Sagamore Rotary, north of the Bourne Bridge, was reconstructed as a highway interchange in 2006. These intersections and several others along Sandwich Road and Scenic Highway experience severe congestion (LOS E / F) during both the summer and non-summer periods.

massDOT
Massachusetts Department of Transportation

# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# CONTENTS

# EXHIBITS

# TABLES

# Alternatives Development and Analysis

This chapter describes the alternatives development and analysis process conducted to identify multimodal transportation improvements that advance the study's goals and objectives (listed in Section 1.4). The development of alternatives was guided by MassDOT' s Project Development and Design Guide (with consideration of the study's issues, constraints, and opportunities described in Section 2.8) and the study's design assumptions. Through regular and meaningful coordination, the study Working Group provided substantial input into the alternative's development process.

This process was also influenced by the U.S. Army Corps of Engineers (USACE) on-going planning study of the Bourne and Sagamore Bridges. The result of their study will be a decision by the USACE to either continue to maintain the Bourne and Sagamore Bridges or prepare for their replacement. This decision may not be the same for both bridges.

While MassDOT and the USACE are coordinating their respective study efforts, it is acknowledged that the potential transportation

improvements described in this chapter represent conceptual scenarios that could occur in the future given the uncertainties in permitting, funding, and actions by the USACE affecting the study area's transportation system. Ultimately, continued coordination would be required between the USACE and MassDOT to ensure that future infrastructure investments by these agencies are compatible with each other in terms of alignment, design elements and standards, and future travel demand.

## 4.1 DESIGN APPROACH AND ASSUMPTIONS

MassDOT' s standard approach to alternatives development was used, which focuses on:

- Satisfying the study goals and objectives (Section 1.4);
- Consideration of issues, constraints, and opportunities (Section 2.8); and
- Minimizing impact to property, community facilities, and environmental resources.

Also, recognizing that Cape Cod is a major summertime tourist destination and trying to design transportation improvements to accommodate the summertime peak period traffic volumes would require the construction of very substantial infrastructure improvements. In consultation with the Working Group, it was concluded that this level of infrastructure would likely be considered an 'over-build' not in line with the type or scale of development desired on Cape Cod. As a result, the following **assumptions** guided the alternatives analysis process:

- Focus on future (2040) year-round safety and mobility problem locations;
- Focus on improvements to existing infrastructure;
- Focus on improvements that reduce cut-through traffic on local roadways;
- Design to accommodate the future (2040) non-summer weekday PM peak period traffic volumes;
- Provide further feasible improvements to accommodate summer Saturday peak period travel volumes, in line with community character;
- Design in accordance with design standards and processes found within the MassDOT Project Development and Design Guide, LRFD Bridge Manual, Separated Bike Lane Planning and Design Guide, and other MassDOT design standards, as appropriate.
- Design will incorporate Intelligent Transportation System (ITS) improvements to provide real-time traveler

information, weather conditions, work-zone management, and emergency management information.

- Recommended alternatives to be compatible with future Canal bridges with minimal modification; and
- Replacement Canal bridges to be built adjacent to existing bridges. The replacement Bourne Bridge would be located immediately to the east of the existing bridge and the replacement Sagamore Bridge immediately to the west (this assumption is made with the knowledge that the Canal bridges are owned by the USACE who will decide if the Canal bridges will be replaced or rehabilitated).

## 4.2 ALTERNATIVES DEVELOPMENT AND ANALYSIS

Transportation improvement alternatives were developed - in coordination with the Working Group and based on the existing and future traffic conditions and environmental constraints in the study area. The 'design assumptions' described above provided a framework for the development of these alternatives.

As noted in Section 4.1, evaluation of potential improvements focused on 'year-round problem intersections'. These are intersections (listed on Table 3 7) that operate (or are forecast to operate) as a LOS E or F during at least one summer Saturday and non-summer weekday peak travel period in 2014 or 2040. Problem intersections also include those identified as high-crash locations under the Highway Safety Improvement Program (HSIP). While not meeting the definition of a 'year-round problem intersection', the Scenic Highway at Nightingale Pond Road intersection and the Route 6 Exit 1C interchange were also evaluated due to their effect on traffic operations in the study area.

Overall, eight locations were advanced to alternatives development (Table 4-1). Several of these are a combination of more than one year-round problem intersection, as proximity to one another resulted in them operating as a single traffic point.

Transportation improvements were developed in accordance with the requirements of MassDOT' s Project Development and Design Guide and reflect a commitment to complete streets and mode shift objectives to the degree appropriate for each individual location, consistent with the principles of MassDOT' s Healthy Transportation Policy Directive. This policy seeks to increase and encourage the use of a greater variety of transportation modes including walking, bicycling, and transit.

Table 4-1 Future (2040) Year-Round Problem Intersections

| LOCATION NO. ON EXHIBIT 3-19/3-20 | LOCATION | TOWN | HIGH CRASH CLUSTER[1] | LOS E OR F (2040) |
|---|---|---|---|---|
| 8 | Scenic Highway/Meetinghouse Lane at Canal Street/State Road | Bourne | Yes | Yes |
| 10/11[2] | Sandwich Road at Bourne Rotary Connector/High School Drive | Bourne | Yes | Yes |
| 15 | Route 6A (Sandwich Road) at Cranberry Highway | Bourne | No | Yes |
| 21 | Route 130 at Cotuit Road | Sandwich | Yes | Yes |
| 4/52 | Belmont Circle and Scenic Highway at Nightingale Pond Road | Bourne | Yes | Yes |
| 9 | Bourne Rotary | Bourne | Yes | Yes |
| 16/17 | Route 6A/Route 130/ Tupper Road[3] | Sandwich | Yes | No |
| N/A | Route 6 Exit 1C Relocation[4] | Bourne | No | No |

*1 High crash locations identified by MassDOT for the 2011-2013 or 2012-2014 periods.*
*2 Locations combined due to their proximity.*
*3 To be combined with Route 6 Exit 1C Relocation.*
*4 Advanced to Alternatives Development due to substandard design.*

Ultimately, the recommended alternatives were developed to address the evaluation criteria (described in Section 1.5). These alternatives were compared to each other to identify a suite of recommended build alternatives. An evaluation matrix is provided for each of the travel demand model cases described in Section 5.2. The evaluation matrix provides a summary of the analysis of the recommended alternatives against the evaluation criteria.

### 4.2.1 Traffic Analysis – Measures of Effectiveness

As described in Section 2.5.5, the measures of effectiveness for the traffic analysis are based on level of service (LOS) and queue lengths (which is a measure of intersection delay). Delay is defined as the difference between travel time during free-flow travel periods and the travel time during congested conditions.

LOS is a qualitative measure used to relate the quality of peak-hour traffic operating conditions. LOS is based on density for highway sections and ramps and average delay traffic at intersections. LOS ranges from A, the optimal free-flow condition, to F, where traffic demands are beyond roadway capacity or create excessive delays (Table 2-17). LOS E or LOS F is generally considered to be unacceptable travel delay.

While LOS is a useful measure of effectiveness along highways and signalized and unsignalized intersections, it is not a helpful measure at complex, non-traditional traffic circles such as Belmont Circle and the Bourne Rotary which are described in terms of queuing, vehicle delays, and travel time.

Queues are the length of a line of vehicles waiting to pass through an intersection, generally calculated during the peak period. These vehicles may be stopped or advancing slowing. The

50% queue is the median length of this line of vehicles (during the peak hour) and the 95% queue is the maximum length of this line of vehicles.

Generally, each vehicle (including the space between vehicles) occupies approximately 25 feet; so a queue of 250 feet includes approximately 10 vehicles.

### 4.2.2 Conceptual Cost Estimate Methodology

Conceptual cost estimates were prepared for each of the potential transportation improvements. The cost estimates were based on MassDOT 2017 unit costs per linear foot of new roadway and bridge sections (see the methodology section of Appendix E).

The cost estimates were escalated by 4% per year to develop cost for 2017, 2030, and 2040, to provide an understanding of the increasing cost of these projects at different time periods. The conceptual cost estimates, including the unit costs for various roadway and bridge sections, are provided in Appendix E.

The unit-costs for the various alternatives were increased by an additional 25% to 40% to account for contingencies such as environmental mitigation, traffic management, utility relocation, traffic management and/or structural elements (such as retaining walls). A lower contingency was used for less complex design alternatives (e.g., local intersection improvements) while a 40% contingency was used for larger, more complex mid- and long-term design alternatives. A 75% contingency was used for larger projects involving substantial utility conflicts/potential relocations. The conceptual cost estimates do not include the costs of design, permanent or temporary right-of-way costs, or construction engineering.

## 4.3 ROADWAY IMPROVEMENT ALTERNATIVES ANALYSIS

The following sections describe the transportation improvements alternatives developed for the year round problem intersections listed in Table 4-1. Based on anticipated project complexity and cost, these potential improvements are divided into ‘local intersection improvements’ and ‘gateway intersection improvements’. The gateway intersections are those immediately adjacent to the Bourne and Sagamore Bridges, including Belmont Circle, Bourne Rotary, and Route 6 Exit 1C. A brief description of each location is provided, including roadway layout, adjacent land uses and environmental resources. A summary of the existing and future traffic conditions is also provided.

For clarity, traffic operations are provided for the two key travel periods; the non-summer weekday PM period (4:00 – 6:00

PM) and the summer Saturday (10:00 AM to 12:00 PM) period. The non-summer weekday PM period represents the weekday commuter period and the summer Saturday represents the peak travel period for visitors.

More detailed information related to existing and future traffic operations at these locations is provided in Chapters 2 (Section 2.5) and Chapter 3 (Section 3.3), respectively, and Appendix H.

### 4.3.1 Working Group Transportation Improvement Submissions

Numerous thoughtful suggestions for transportation system improvements were received from individual members of the Working Group or members of the public. Each of these concepts was considered to ascertain whether they warranted inclusion in the alternatives analysis. Several of these concepts were similar to alternatives already being pursued by the study. These transportation improvement concepts and the results of the evaluation of them are provided in Table 4-2.

*Table 4-2 Working Group Submissions*

| TRANSPORTATION SYSTEM CONCEPT | RESULT OF STUDY EVALUATION |
|---|---|
| Funding transportation improvements through bridge tolling | Bridge tolling not allowed by USACE bridge legislation (PL 516, Chapter 188, Section 109 33 USC 534) |
| Expanded rail service | Expanding rail service would improve multimodal mobility on Cape Cod, however it would not have the capacity to meaningfully alleviate traffic congestion in study area. |
| Additional Canal bridges and approach highways connecting Route 25 to Route 6 | Not advanced due to substantial environmental impact; including wetlands, ACECs, open space, and tribal resources.<br><br>Contrary to the goal of focusing on existing infrastructure. |
| Cross-Canal tunnel | Based on conceptual analysis, tunneling options not advanced due to high cost of construction and maintenance compared to bridge options and substantial property acquisition requirements. |
| Route 6 Exit 2 (Route 130) improvements | Additional capacity at Exit 2 not needed. |
| Scenic Highway to Route 25 entrance ramp | Concept advanced into conceptual design (see Section 4.6.4). |
| Sandwich Road capacity improvements | Capacity improvements not needed on Sandwich Road. Widening Sandwich Road would also result in substantial impact to public open space. |
| Bourne Rotary Improvements | Similar concept advanced into conceptual design (see Section 4.6.5). |

## 4.4 LOCAL INTERSECTION IMPROVEMENTS

Improvements to local intersections include incorporation of Transportation System Management (TSM) measures at key intersections in the study area. Examples of TSM improvements include: traffic signal optimization, installation of new traffic signals and/or signal control equipment, installation of turning lanes, and improved roadway markings and signage. Local intersection improvements generally take less than three years to implement.

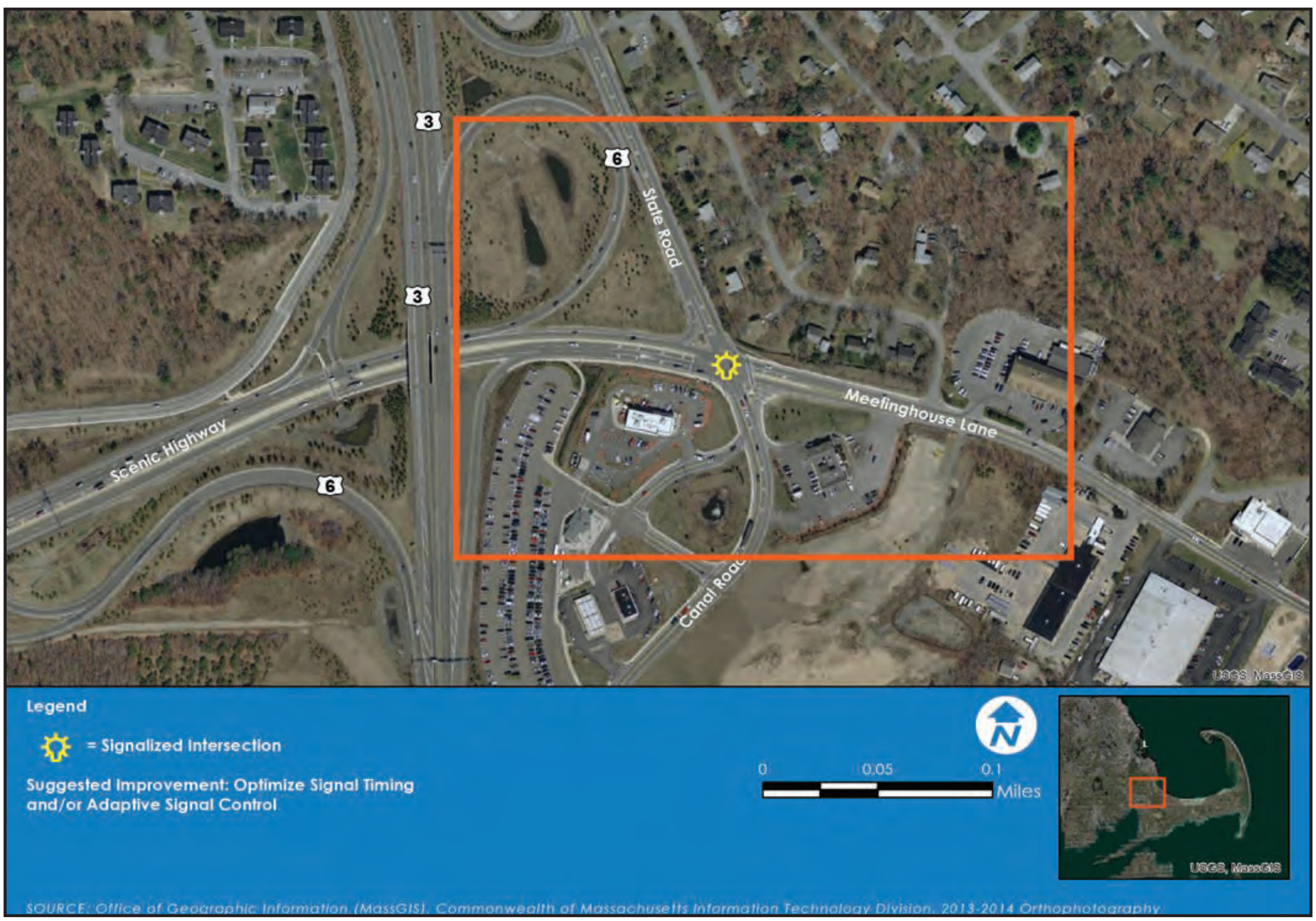
Conceptual cost estimates were prepared for each of the potential transportation improvements. The methodology used for preparing the cost estimates can be found in Section 4.2.2. More detailed conceptual cost estimates are provided in Appendix E.

### 4.4.1 Scenic Highway/Meetinghouse Lane at Canal Road/State Road

*Existing Conditions*

The Scenic Highway/Meetinghouse Lane intersection with Canal Road/State Road in Bourne (Exhibit 4-1) is a signalized

**Exhibit 4-1 Scenic Highway/Meetinghouse Lane at Canal Road/State Road**



intersection north of the Cape Cod Canal. The intersection is immediately east of Route 6 Exit 1A (Sagamore interchange). Each approach to the intersection features multiple lanes providing separate through or left-turn lanes. The Scenic Highway eastbound approach has three lanes; a right-, through-, and left-turn lane.

At this intersection, sidewalks exist on the south side of the Scenic Highway, the north side of Meetinghouse Lane and both sides of Canal Road. Crosswalks on both sides of Canal Road lead pedestrians to a roadway island and then to the north side of Meetinghouse Lane.

### *Land Uses and Environmental Resources*

MassDOT' s Sagamore Park & Ride lot, a McDonald's restaurant, a Dunkin' Donuts restaurant, and a Shell gas station are accessed from Canal Road south of the intersection. Residential properties are present along Homestead Road at the northeast quadrant of the intersection. The northwest quadrant of the intersection features highway ramps and grassed areas related to the Route 6 at Scenic Highway interchange. No regulated environmental resources exist at this intersection.

### *Traffic Conditions*

This intersection experiences high traffic volumes during both the non-summer weekday PM and the summer Saturday periods because of its proximity to the Route 6 at Scenic Highway interchange (Table 4-3). These high traffic volumes result in predominately LOS C and D during non-summer weekday and summer Saturdays for the existing and future periods. LOS F conditions are forecast in 2040 during the non summer weekday PM peak period for several intersection approaches, including Scenic Highway eastbound and Meetinghouse Lane westbound.

### *Suggested Improvements*

The optimization of the timing of the traffic signals would provide more efficient processing of vehicles traveling through the intersection. Traffic signal optimization generally reduces overall intersection delay by approximately 10%, which can improve LOS. With traffic signal optimization, the non-summer weekday PM peak period is forecast to improve from LOS F to LOS E. During the non-summer weekday PM peak period, average delay at the intersection would be reduced from140 seconds to 66 seconds. Delay during the summer Saturday peak period would improve from 34 seconds to 23 seconds (Table 4-3).

The installation of 'adaptive signal control' should also be evaluated. Adaptive signal control uses real-time traffic

Table 4-3 *Traffic Operations – Scenic Hwy/Meetinghouse Lane at Canal Road/State Road*

| | EXISTING (2014) CONDITIONS | | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | | FUTURE (2040) BUILD CONDITIONS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 50% QUEUE *Feet (Miles)* | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 50% QUEUE *Feet (Miles)* | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 50% QUEUE *Feet (Miles)* | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | | | |
| Scenic Highway EB Lt | 26 | C | 0.78 | 225 | 450 | 173 (2.9) | **F** | 1.3 | 621 | 930 | 84 (1.4) | **F** | 1.06 | 779 | 1,035 |
| Scenic Highway EB Th | 21 | C | 0.35 | 87 | 202 | 25 | C | 0.5 | 134 | 298 | 10 | B | 0.3 | 130 | 181 |
| Scenic Highway EB Rt | 18 | B | 0.12 | 0 | 8 | 19 | B | 0.14 | 0 | 29 | 9 | A | 0.14 | 0 | 27 |
| Meetinghouse Ln WB Lt | 38 | D | 0.09 | 4 | 16 | 38 | D | 0.14 | 6 | 21 | 46 | D | 0.11 | 16 | 42 |
| Meetinghouse Ln WB Th/Rt | 156 (2.6) | **F** | 1.16 | 146 | 295 | 418 (7.0) | **F** | 1.79 | 305 | 488 | 99 (1.7) | **F** | 0.99 | 325 | 538 |
| Canal Road NB Lt | 45 | D | 0.62 | 96 | 153 | 45 | D | 0.67 | 115 | 175 | 129 (2.2) | **F** | 1.01 | 176 | 340 |
| Canal Road NB Th/Rt | 33 | C | 0.29 | 65 | 116 | 32 | C | 0.33 | 81 | 134 | 46 | D | 0.37 | 115 | 186 |
| State Road SB Lt | 49 | D | 0.34 | 17 | 44 | 50 | D | 0.46 | 23 | 56 | 66 | **E** | 0.44 | 34 | 74 |
| State Road SB Th | 39 | D | 0.11 | 16 | 42 | 39 | D | 0.14 | 20 | 49 | 62 | **E** | 0.25 | 29 | 66 |
| State Road SB Rt | 39 | D | 0.08 | 0 | 0 | 39 | D | 0.1 | 0 | 0 | 61 (1.0) | **E** | 0.1 | 0 | 72 |
| **Intersection (Overall)** | **46.8** | **D** | **0.74** | | | **140 (2.3)** | **F** | **1.09** | | | **66.5 (1.1)** | **E** | **1.03** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | | | |
| Scenic Highway EB LT | 14 | B | 0.34 | 73 | 149 | 16 | B | 0.42 | 81 | 154 | 13 | B | 0.49 | 57 | 100 |
| Scenic Highway EB Th | 22 | C | 0.35 | 147 | 274 | 25 | C | 0.49 | 226 | 386 | 14 | B | 0.45 | 123 | 196 |
| Scenic Highway EB Rt | 19 | B | 0.14 | 0 | 52 | 20 | C | 0.17 | 0 | 59 | 11 | B | 0.17 | 0 | 37 |
| Meetinghouse Ln WB Lt | 20 | C | 0.07 | 11 | 33 | 21 | C | 0.09 | 13 | 37 | 22 | C | 0.15 | 14 | 38 |
| Meetinghouse Ln WB Th/Rt | 27 | C | 0.31 | 106 | 220 | 31 | C | 0.49 | 185 | 368 | 32 | C | 0.67 | 130 | 250 |
| Canal Road NB Lt | 32 | C | 0.51 | 129 | 165 | 33 | C | 0.58 | 148 | 192 | 30 | C | 0.74 | 87 | 165 |
| Canal Road NB Th/Rt | 44 | D | 0.58 | 161 | 214 | 49 | D | 0.7 | 191 | 257 | 21 | C | 0.46 | 88 | 155 |
| State Road SB Lt | 42 | D | 0.21 | 27 | 47 | 43 | D | 0.35 | 47 | 74 | 36 | D | 0.59 | 37 | 82 |
| State Road SB Th | 49 | D | 0.38 | 68 | 110 | 51 | D | 0.48 | 80 | 131 | 31 | C | 0.43 | 46 | 91 |
| State Road SB Rt | 48 | D | 0.3 | 0 | 99 | 49 | D | 0.26 | 0 | 95 | 30 | C | 0.26 | 0 | 78 |
| **Intersection (Overall)** | **32.6** | **C** | **0.47** | | | **34.1** | **C** | **0.60** | | | **23.0** | **C** | **0.76** | | |

*Notes:*
- *LOS E and LOS F movements are shaded* ***bold***
- *Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
- *LOS = Level of Service.*
- *V/C = Volume to Capacity Ratio*
- *Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

information to actively adjust signal timing at each approach. This technology can further reduce traffic congestion and delay. Although ADA-compliant sidewalks and crosswalks already exist at this intersection, they should be evaluated to ensure a state of good repair.

#### *Property or Environmental Resource Impact*

Signal optimization would not impact any regulated environmental resources. No property taking would be required.

#### *Conceptual Cost Estimate*

The cost of these improvements would range from approximately $25,000 to $50,000 (2017 costs).

### 4.4.2 Sandwich Road at Bourne Rotary Connector

#### *Existing Conditions*

Sandwich Road at Bourne Rotary Connector in Bourne (Exhibit 4-2) is an unsignalized Y intersection immediately east of the Bourne Rotary, which is south of the Cape Cod Canal. Each approach to the intersection features a single lane. The Bourne

***Exhibit 4-2 Existing Conditions - Sandwich Road at Bourne Rotary Connector***

Rotary Connector provides direct access from Sandwich Road to the Bourne Rotary (and the Bourne Bridge and other points north). The combination of the Bourne Rotary Connector and Sandwich Road (east of the intersection) acts as the through movement at this intersection with the Sandwich Road approach from the west acting as the minor roadway approach. There are no sidewalks or crosswalks on any of the approaches to this intersection.

### *Land Uses and Environmental Resources*

Except for three residential properties, land uses north of the intersection consist of public open space owned by either the Town of Bourne or the U.S. Army Corps of Engineers. The Cape Cod Regional Technical High School property is southeast of the intersection (with its entrance drive approximately 1,000 feet east on Sandwich Road).

There are no wetlands, floodplains, or other regulated water resources within 100 feet of the intersection. Land south of the intersection is designated by the Massachusetts Natural Heritage and Endangered Species Program as a 'Priority Habitat for Rare Species'.

### *Traffic Conditions*

This intersection experiences high traffic volumes during both the non-summer weekday PM and the summer Saturday peak periods. Combined with the lack of signalization at this intersection, these factors result in LOS F conditions during existing and future at the Old Sandwich Road eastbound approach for left-turning vehicles entering Sandwich Road.

### *Suggested Improvements*

The effectiveness of installing traffic signals at this intersection (Exhibit 4-3) was evaluated. Both the Sandwich Road eastbound and the Bourne Rotary Connector eastbound approach would have designated left-turn lanes. Additionally, a through-lane would provide a direct connection from the Bourne Rotary Connector to Sandwich Road eastbound. This movement would be free-flow, instead of being subject to traffic signals. This through lane would be separated from the other lanes with a raised median barrier.

Due to these improvements, traffic operations along the Old Sandwich Road eastbound approach would be improved considerably from LOS F to LOS C for the non-summer weekday PM period (Table 4-4). Overall, this intersection would operate at LOS A and LOS B for the non-summer weekday and summer Saturday peak periods, respectively. The timing of the new traffic

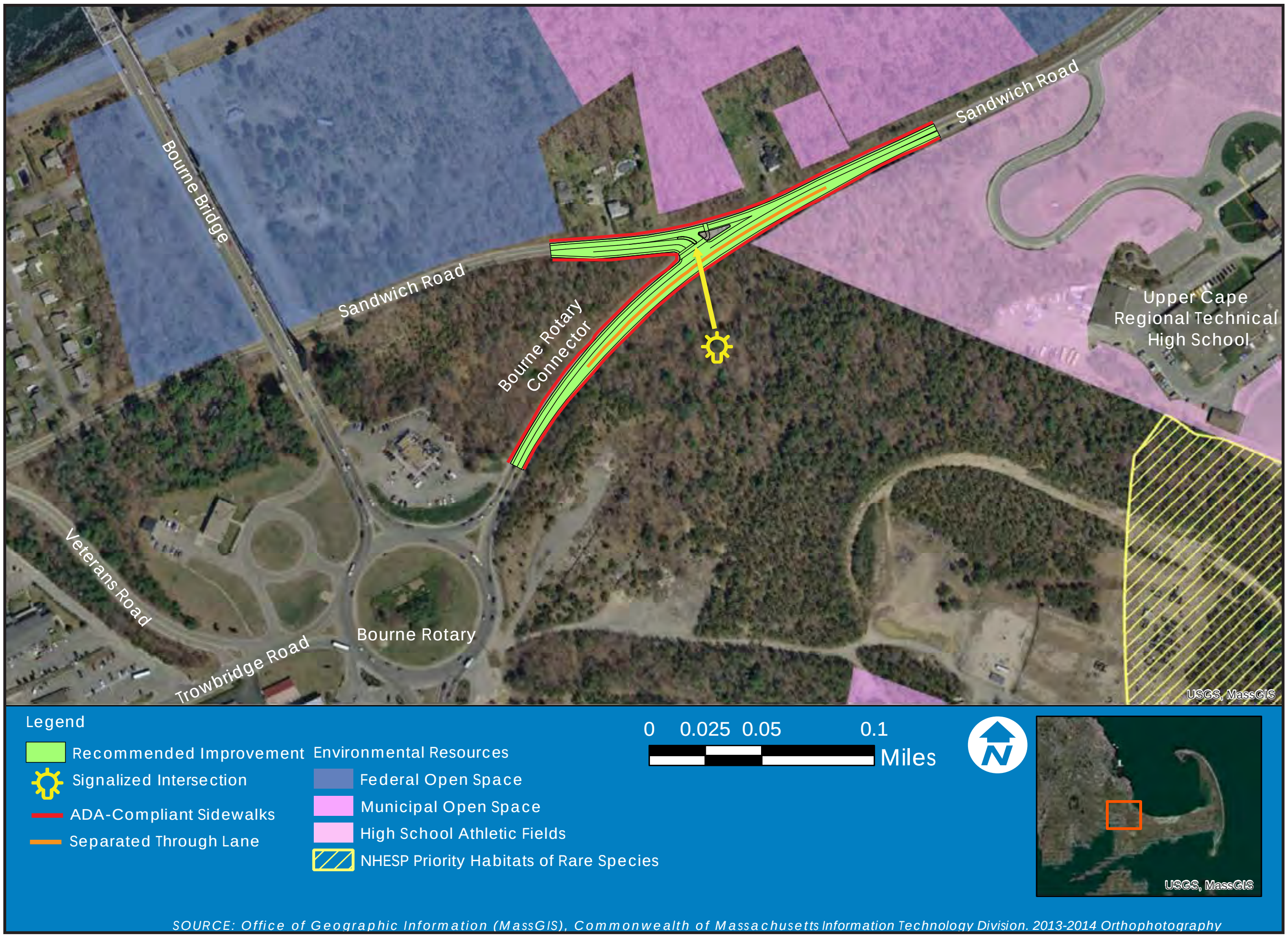



***Exhibit 4-3 Sandwich Road at Bourne Rotary Connector***

signals would be optimized to provide more efficient processing of vehicles traveling through the intersection. The installation of 'adaptive signal control' would also be evaluated.

Improvements to bicycle/pedestrian facilities including ADA-compliant sidewalks and crosswalks along Sandwich Road, in addition to a sidewalk connection to the Technical High School driveway are also proposed. In addition to the roadway travel lanes, shoulders would provide safe accommodation for bicyclists.

### *Property or Environmental Resource Impact*

The improvements may require the acquisition of less than 1,000 square feet of Town of Bourne open space and undeveloped commercial property. No regulated wetland/water resources would be impacted.

*Table 4-4* *Traffic Operations - Sandwich Road at Bourne Rotary Connector*

| | EXISTING (2014) CONDITIONS | | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | | FUTURE (2040) BUILD CONDITIONS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **50% QUEUE** *Feet (Miles)* | **95% QUEUE** *Feet (Miles)* | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **50% QUEUE** *Feet (Miles)* | **95% QUEUE** *Feet (Miles)* | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **50% QUEUE** *Feet (Miles)* | **95% QUEUE** *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | | | |
| Bourne Rotary Connector NEB Lt/Th | 0 | A | 0 | -- | 0 | 0 | A | 0 | -- | 0 | | | | | |
| Sandwich Rd WB Th/Rt | 0 | A | 0.57 | -- | 0 | 0 | A | 0.69 | -- | 0 | | | | | |
| Old Sandwich Road EB Lt | 537 (8.9) | **F** | 1.89 | -- | 313 | n/a | **F** | 3.35 | -- | n/a | 22 | C | 0.54 | 69 | 127 |
| Old Sandwich Road EB Rt | 47 | **E** | 0.82 | -- | 179 | 131 (2.2) | **F** | 1.14 | -- | 363 | 14 | B | 0.47 | 63 | 131 |
| Bourne Rotary Connector NEB Lt | | | | | | | | | | | 0 | A | 0 | 0 | 0 |
| Bourne Rotary Connector NEB Th | | | | | | | | | | | 1 | A | 0.59 | 0 | 0 |
| Sandwich Road WB Th | | | | | | | | | | | 17 | B | 0.79 | 205 | 436 |
| Sandwich Road WB Rt | | | | | | | | | | | 9 | A | 0.29 | 0 | 41 |
| **Intersection (Overall)** | | | | | | | | | | | **9.7** | **A** | **0.78** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | | | |
| Bourne Rotary Connector NEB Lt/Th | 1 | A | 0.02 | -- | 2 | 1 | A | 0.03 | -- | 2 | | | | | |
| Sandwich Rd WB Th/Rt | 0 | A | 0.65 | -- | 0 | 0 | A | 0.67 | -- | 0 | | | | | |
| Old Sandwich Road EB Lt | 606 (10.1) | **F** | 1.74 | -- | 165 | n/a | **F** | 6.25 | -- | n/a | 36 | D | 0.7 | 108 | 192 |
| Old Sandwich Road EB Rt | 27 | D | 0.41 | -- | 48 | 31 | D | 0.5 | -- | 66 | 19 | B | 0.15 | 14 | 52 |
| Bourne Rotary Connector NEB Lt | | | | | | | | | | | 33.1 | C | 0.13 | 10 | 32 |
| Bourne Rotary Connector NEB Th | | | | | | | | | | | 2.2 | A | 0.69 | 0 | 0 |
| Sandwich Road WB Th | | | | | | | | | | | 23.9 | C | 0.9 | 396 | 715 |
| Sandwich Road WB Rt | | | | | | | | | | | 7 | A | 0.12 | 0 | 25 |
| **Intersection (Overall)** | | | | | | | | | | | **13.9** | **B** | **0.89** | | |

*Notes:*
- *LOS E and LOF movements are **bold***
- *Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
- *LOS = Level of Service; V/C = Volume to Capacity Ratio*
- *Overall LOS, V/C and queues not calculated for unsignalized intersections.*
- *Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
- *n/a = Volume exceeds capacity to the point where the respective value cannot be determined.*
- *Shaded areas do not exist in listed configuration during this period.*

### *Conceptual Cost Estimate*

Reconstruction and signalization at the Sandwich Road at Bourne Rotary Connector intersection would cost approximately $1.9 million (2017 costs). More detailed conceptual cost estimates are provided in Appendix E.

## 4.4.3 Route 6A (Sandwich Road) at Cranberry Highway

### *Existing Conditions*

The Sandwich Road at Cranberry Highway intersection in Bourne (Exhibit 4-4) is an unsignalized Y-intersection approximately 0.75-miles east of the Route 6/Cranberry Highway Interchange (Exit 1C). Each approach to the intersection features a single lane. The Cranberry Highway eastbound approach has a channelized right-turn lane separated from the left-turn lane by a large traffic island.

Regency Drive, a dead-end residential street, has access from Sandwich Road directly opposite the Cranberry Highway approach. The north side of Sandwich Road has sidewalks that

***Exhibit 4-4 Existing Conditions - Route 6A (Sandwich Road) at Cranberry Highway***

are frequently interrupted by driveways. These sidewalks are generally not ADA-compliant. There are no sidewalks along Cranberry Highway, or any crosswalks on any of the approaches to this intersection.

### *Land Uses and Environmental Resources*

Land uses in the area include residential properties along Sandwich Road, and a gas station and a convenience store on the parcel between Sandwich Road and Cranberry Highway. The Cranberry Highway approach features a mix of residential properties, a cranberry bog, restaurant, and an auto salvage yard.

There are no wetlands, floodplains, or other regulated water resources within 100 feet of the intersection. The entire intersection is within an interim wellhead protection area of a public water supply.

### *Traffic Conditions*

This intersection experiences generally acceptable traffic conditions (LOS A and B) except for the Cranberry Highway east-bound approach. Left-turning vehicles on this approach experience LOS E and F conditions during the future non-summer weekday PM and the summer Saturday periods, respectively. Vehicles entering this intersection from Regency Drive are expected to experience LOS F conditions during the future non summer weekday peak period.

### *Suggested Improvements*

The suggested improvements include the construction of a left-turn lane on the Sandwich Road westbound approach (Exhibit 4 5). This left-turn lane would reduce queuing on this approach that currently form behind vehicles on Sandwich Road westbound turning left onto Cranberry Highway. Reducing these queues would create more gaps in traffic, allowing vehicles from Cranberry Highway to more easily enter Sandwich Road (Table 4-5). During the non-summer weekday PM peak period, traffic operations for vehicles entering from Regency Drive would improve from LOS F to LOS B.

Improvements to bicycle/pedestrian facilities including ADA-compliant sidewalks and crosswalks along Sandwich Road and Cranberry Highway are also proposed. Roadway shoulders would be widened to provide safer accommodation for bicyclists.

### *Property or Environmental Resource Impact*

The improvements may require the acquisition of less than 1,000 square feet of residential property. No regulated environmental resources would be impacted.


*Exhibit 4-5 Route 6A (Sandwich Road) at Cranberry Highway*

### *Conceptual Cost Estimate*

These improvements would cost approximately $584,000 (2017 costs). More detailed conceptual cost estimates are provided in Appendix E.

## 4.4.4 Route 130 (Forestdale Road) at Cotuit Road

### *Existing Conditions*

The Route 130 (Forestdale Road) at Cotuit Road intersection in Sandwich (Exhibit 4-6) is an unsignalized T intersection approximately 1.6 miles south of the Route 6/Route 130 (Exit 2) interchange. The Route 130 southbound approach to the intersection has two lanes; a through- and a left-turn lane. The Route 130 northbound approach is a single-lane approach. The Cotuit Road northbound approach is stop-controlled and has two lanes; a left- and right-turn lane.

There are no sidewalks or crosswalks on Route 130 or Cotuit Road near the intersection. Route 130 has roadway shoulders, approximately eight feet in width, on both sides of the road. Cotuit Road has three-foot shoulders.

Table 4-5 Traffic Operations - Route 6A (Sandwich Road) at Cranberry Highway

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | FUTURE (2040) BUILD CONDITIONS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | |
| Sandwich Road EB Lt/Th/Rt | 0 | A | 0 | 0 | 0 | A | 0 | 0 | 0 | A | 0 | 0 |
| Sandwich Road WB Lt | | | | | | | | | 22 | A | 0.22 | 22 |
| Sandwich Road WB Lt/ Th/Rt | 4 | A | 0.18 | 16 | 22 | A | 0.22 | 22 | 0 | A | 0.23 | 0 |
| Cranberry Hwy EB Lt/Th | 32 | D | 0.07 | 5 | 8 | **E** | 0.1 | 8 | 8 | E | 0.1 | 8 |
| Cranberry Hwy EB Rt | 12 | B | 0.08 | 7 | 9 | B | 0.11 | 9 | 9 | B | 0.11 | 9 |
| Regency Drive SB Lt/Th/Rt | 35 | D | 0.04 | 3 | 5 | **A** | 0.06 | 5 | 1 | B | 0.01 | 1 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | |
| Sandwich Road EB Lt/Th/Rt | 0 | A | 0.01 | 0 | 0 | A | 0.01 | 0 | 0 | A | 0.01 | 0 |
| Sandwich Road WB Lt | | | | | | | | | 184 (3.1) | C | 0.75 | 184 |
| Sandwich Road WB Lt/ Th/Rt | 14 | B | 0.61 | 110 | 184 (3.1) | C | 0.75 | 184 | 0 | A | 0.36 | 0 |
| Cranberry Hwy EB Lt/Th | 1,416 (23.6) | **F** | 2.71 | 124 | n/a | **F** | 7.13 | n/a | n/a | **F** | 7.11 | n/a |
| Cranberry Hwy EB Rt | 12 | B | 0.11 | 9 | 13 | B | 0.15 | 13 | 13 | B | 0.15 | 13 |
| Regency Drive SB Lt/Th/Rt | 12 | B | 0.01 | 1 | 1 | B | 0.01 | 1 | 1 | B | 0.01 | 1 |

*Notes:*
*•LOS E and LOS F movements are **bold***
*•Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*•LOS = Level of Service; V/C = Volume to Capacity Ratio*
*•Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*•Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*•Shaded areas do not exist in listed configuration during this period.*

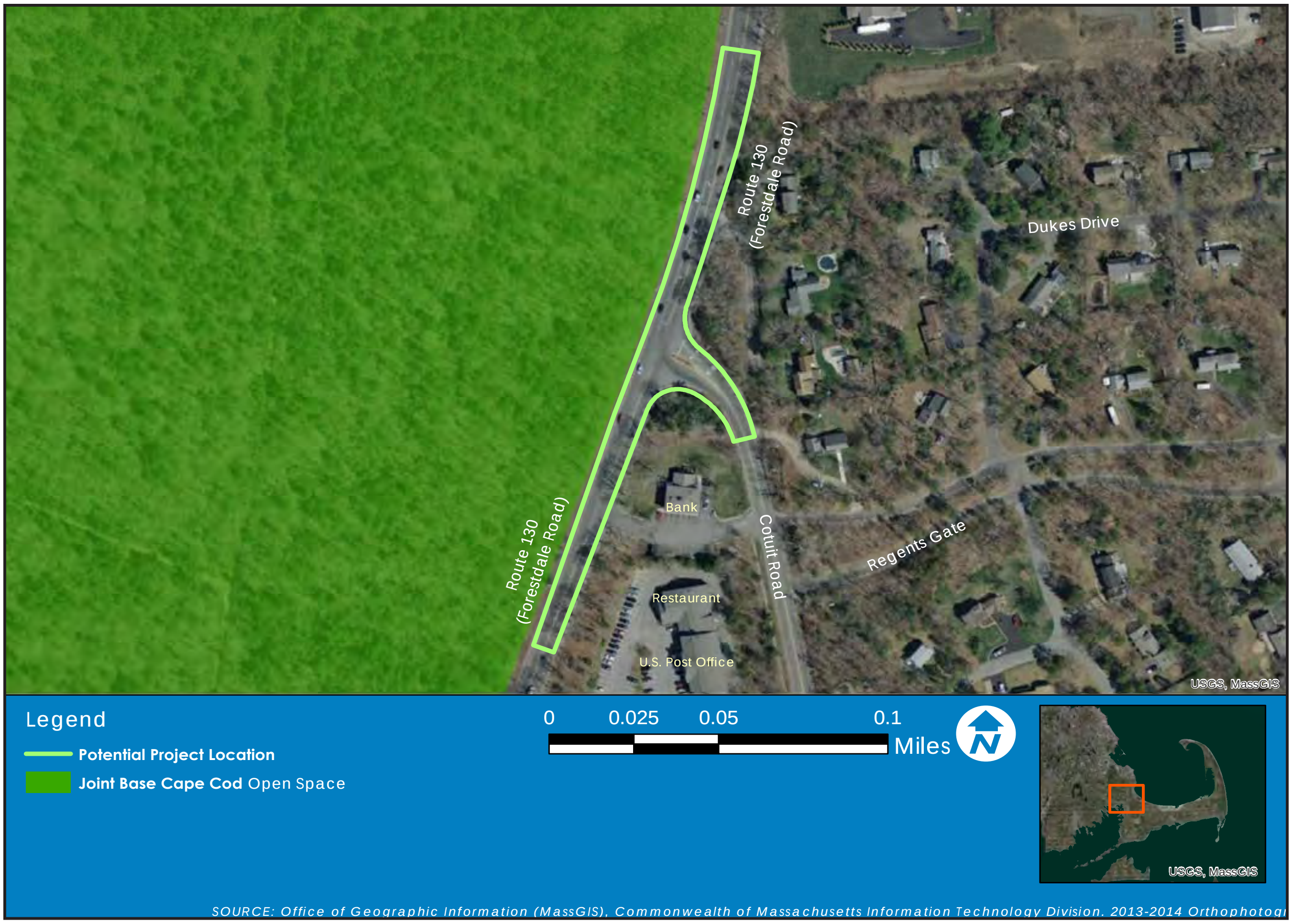



***Exhibit 4-6 Existing Conditions - Route 130 at Cotuit Road***

### *Land Uses and Environmental Resources*

Land uses in the area include residential properties along the east side of Cotuit Road and Route 130. Land to the west of Route 130 is undeveloped forest belonging to Joint Base Cape Cod (JBCC). Numerous commercial developments exist in the land between Route 130 and Cotuit Road.

There are no wetlands, floodplains, or other regulated wetland resources within 100 feet of the intersection. Land west of Route 130 within JBCC is designated by the Massachusetts Natural Heritage and Endangered Species Program as a 'Priority Habitat for Rare Species'.

### *Traffic Conditions*

This intersection experiences generally acceptable traffic conditions (LOS A and B) except for the Cotuit Road northbound approach. Left-turning vehicles on this approach experience LOS F conditions during both the existing and future non-summer weekday PM and the summer Saturday periods (Table 4-6).

Table 4-6 Traffic Operations – Route 130 at Cotuit Road

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | FUTURE (2040) BUILD CONDITIONS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 50% QUEUE Feet (Miles) | 95% QUEUE Feet (Miles) |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | |
| Route 130 NB Th/Rt | 0 | A | 0.25 | 0 | 0 | A | 0.3 | 0 | 19 | B | 0.71 | 141 | 403 |
| Route 130 SB Lt | 11 | B | 0.5 | 72 | 14 | B | 0.64 | 121 | 14 | B | 0.77 | 72 | 285 |
| Route 130 SB Th | 0 | A | 0.27 | 0 | 0 | A | 0.32 | 0 | 1 | A | 0.34 | 0 | 70 |
| Cotuit Road NB Lt | 137 (2.3) | **F** | 0.16 | 12 | 387 (6.5) | **F** | 0.37 | 24 | 33 | C | 0.18 | 2 | 12 |
| Cotuit Road NB Rt | 16 | C | 0.5 | 71 | 27 | D | 0.74 | 157 | 14 | B | 0.49 | 74 | 136 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | |
| Route 130 NB Th/Rt | 0 | A | 0.24 | 0 | 0 | A | 0.33 | 0 | 16 | B | 0.74 | 106 | 281 |
| Route 130 SB Lt | 10 | A | 0.34 | 37 | 12 | B | 0.47 | 65 | 8 | A | 0.63 | 15 | 165 |
| Route 130 SB Th | 0 | A | 0.24 | 0 | 0 | A | 0.25 | 0 | 1 | A | 0.28 | 0 | 56 |
| Cotuit Road NB Lt | 57 | **F** | 0.14 | 11 | 133 (2.2) | **F** | 0.29 | 24 | 28 | C | 0.31 | 3 | 16 |
| Cotuit Road NB Rt | 25 | D | 0.75 | 167 | 88 (1.5) | **F** | 1.07 | 432 | 17 | B | 0.71 | 93 | 228 |
| **Intersection (Overall)** | | | | | | | | | **11.4** | **B** | **0.8** | | |

*Notes:*
*•LOS E and LOS F movements are **bold***
*•Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*•LOS = Level of Service; V/C = Volume to Capacity Ratio*
*•Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*•Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

### *Suggested Improvements*

The installation of a traffic signal at this intersection would provide opportunities for vehicles from Cotuit Road to safely enter Route 130, reducing delays on this approach (Exhibit 4-7).

This would result in an improvement in traffic operations for left-turning vehicles on the Cotuit Road northbound approach from LOS F to LOS C for the non-summer weekday and summer Saturday peak periods. During the non-summer period, this would reduce average delay by 91% (387 seconds reduced to 33 seconds).

Additionally, improvements to pedestrian facilities including ADA-compliant sidewalks along the east side of Route 130 extending to the entrance of the Trade Winds Plaza are also proposed. The roadway shoulders on Route 130, which currently meet MassDOT' s bicycle accommodation standards, would be maintained.

***Exhibit 4-7 Route 130 at Cotuit Road***

### *Property or Environmental Resource Impact*

These improvements may require the acquisition of less than 1,000 square feet of residential property along the roadway frontage. No regulated environmental resources would be impacted.

### *Conceptual Cost Estimate*

The improvements would cost approximately $956,000 (2017 costs). Conceptual cost estimates are provided in Appendix E.

## 4.5 SCREENING-LEVEL ANALYSIS

A screening-level analysis was completed for the potential larger transportation improvements. The initial purpose of the screening-level analysis is to identify potential significant impact to natural and social environmental resources or property. For this screening analysis stage, it is assumed that the existing Canal bridges remain.

This step is completed in anticipation of the requirement of any potential improvements to complete federal and state environmental review in compliance with the National Environmental Policy Act and Massachusetts Environmental Policy Act (NEPA, 40 CFR 1500-1508 and MEPA, 301 CMR 11:00). These environmental laws require federal and state agencies – prior to receiving funding or other approvals – to evaluate the potential environmental effects of their actions and, through a detailed alternative analysis, select an alternative that meets the project purpose and need with the least environmental impact.

Project alternatives that would result in significant environmental or property impact – projects which would be unlikely to receive approval under MEPA and NEPA – were dismissed from further consideration.

Project alternatives that were not anticipated to result in significant environmental impact were advanced to the next stage of the screening analysis, preliminary traffic analysis. Based on a conceptual design, the effectiveness of potential projects as stand-alone improvements were evaluated using future (2040) traffic volumes.

As described in the following sections, a new Canal bridge on new highway alignment (Public-Private Partnership alternatives) were determined to result in significant environmental impact and were dismissed from further consideration. Potential transportation improvements at gateway intersections were advanced to the traffic analysis stage, and through coordination with the Working Group, suggested alternatives were advanced

for further study. Section 4.8 describes the evaluation of combinations of these potential improvements using the regional travel demand model.

### 4.5.1 Public-Private Partnership Alternatives

Concurrent with the beginning of this study, MassDOT began consideration of several projects as potential Public-Private Partnerships (P3). An infrastructure P3 is generally a method of project delivery in which a private entity designs, constructs, finances, and manages a facility in exchange for a portion of the funds generated or through availability payments. In the case of a highway P3 project, the funds generated by the project are generally the tolls charged to users of the facility.

Based on the long-standing highway congestion in the Canal area, the age and condition of the Canal bridges, and the uncertainty of the USACE's plans related to the rehabilitation or replacement of the bridges, MassDOT identified the Canal area as a potential P3 project envisioned to provide major transportation infrastructure improvements including a new highway bridge over the Canal.

The highway alternatives developed as part of this P3 development process were informed by the cross-Canal travel patterns. As described in Section 2.5.9, the origin-destination analysis identified a high percentage of vehicles traveling between the Route 3/Route 6 corridor to the Route 25/Route 28 corridor, particularly during the summer Saturday peak period. The transition from one corridor to the other occurs in the Canal area using either Sandwich Road or Scenic Highway. These movements place tremendous pressure on the interchanges adjacent to the Canal such as the Sagamore Rotary, Belmont Circle, and the Bourne Rotary, which lead to high levels of congestion at these locations during peak travel periods.

#### *P3 Alternatives – Project Description*

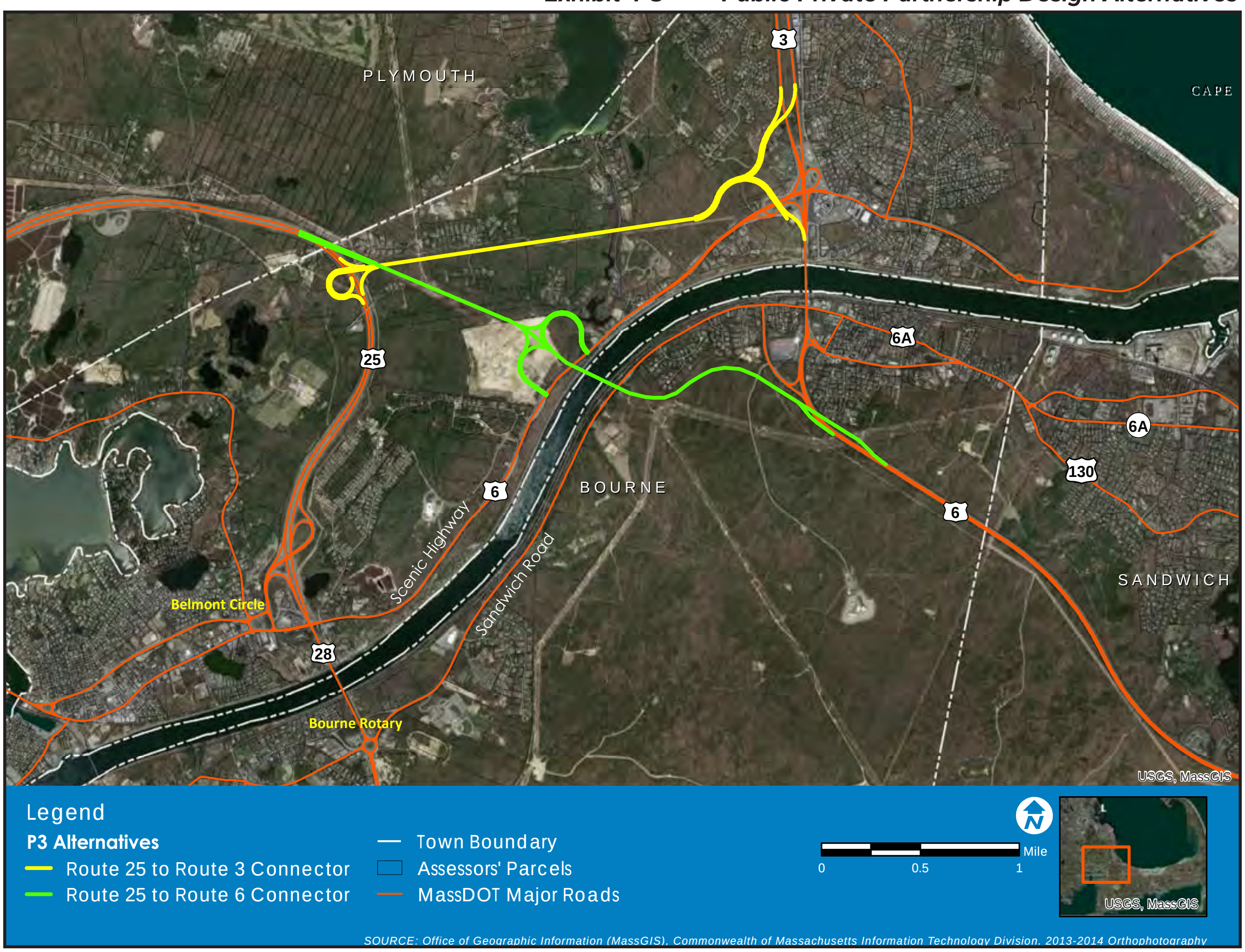
To address this desire for cross-Canal travel, two primary alternatives were developed (Exhibit 4-8). The first alternative would provide a direct roadway connection from Route 25 to Route 3 (north of the Canal). The second alternative would provide a roadway connection from Route 25 to Route 6, including an interchange at Scenic Highway and a new bridge over the Canal. Both alternatives were envisioned to address the high percentage of vehicles traveling between the Route 3/Route 6 highway corridor to the Route 25/Route 28 corridor. These alternatives would be multi-lane highways with interchanges connecting them to the existing highways (Route 3, Route 6, and Route 25).

## *Public-Private Partnership Alternatives – Environmental Impact*

A GIS-based review was conducted to evaluate the potential environmental and social impacts of the two P3 alternatives (Exhibits 4-9 and 4-10). Using a conceptual-level design, the impact analysis was based on two potential roadway widths; a 160-foot width corridor for highway segments having two lanes in each direction and an 80-foot width corridor for those roadway segments and highway ramps having one lane in each direction. As shown on Tables 4-7 and 4-8, each of the P3 alternatives would result in substantial impact to wetlands, open space, Areas of Critical Environmental Concern (ACEC), and rare species habitat. The Route 25 to Route 6 Connector would also impact land within Joint Base Cape Cod (JBCC), the Upper Cape Water Reserve and numerous residential properties.

As noted in Section 2.1.7, the Massachusetts Legislature created the Upper Cape Water Reserve in 2002 to serve as a military training center and as a drinking water and wildlife protection

**Exhibit 4-8    Public-Private Partnership Design Alternatives**



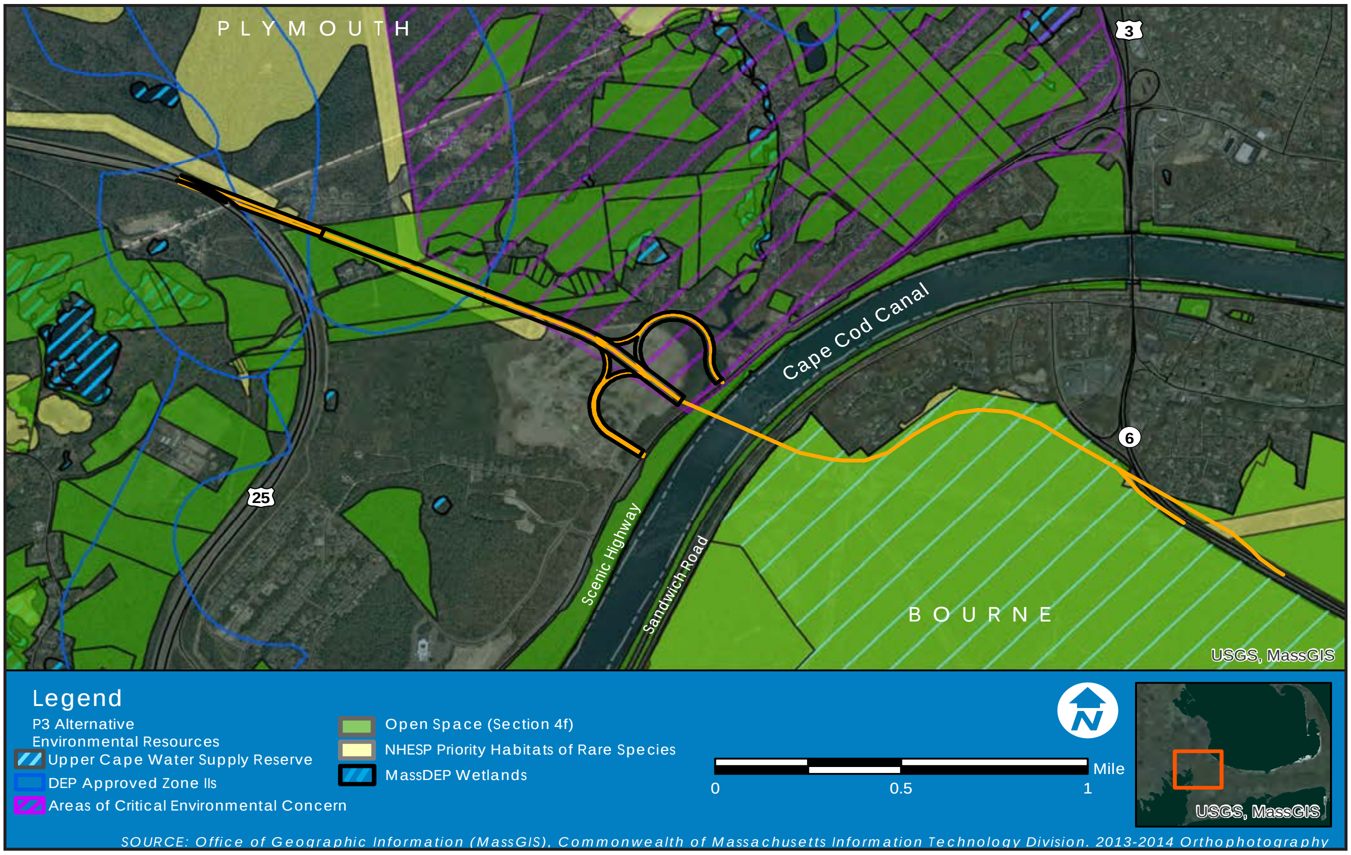



***Exhibit 4-9 Route 25 to Route 6 Connector (Mid-Canal Bridge) – Environmental Impact***

***Exhibit 4-10 Route 25 to Route 3 Connector – Environmental Impact***

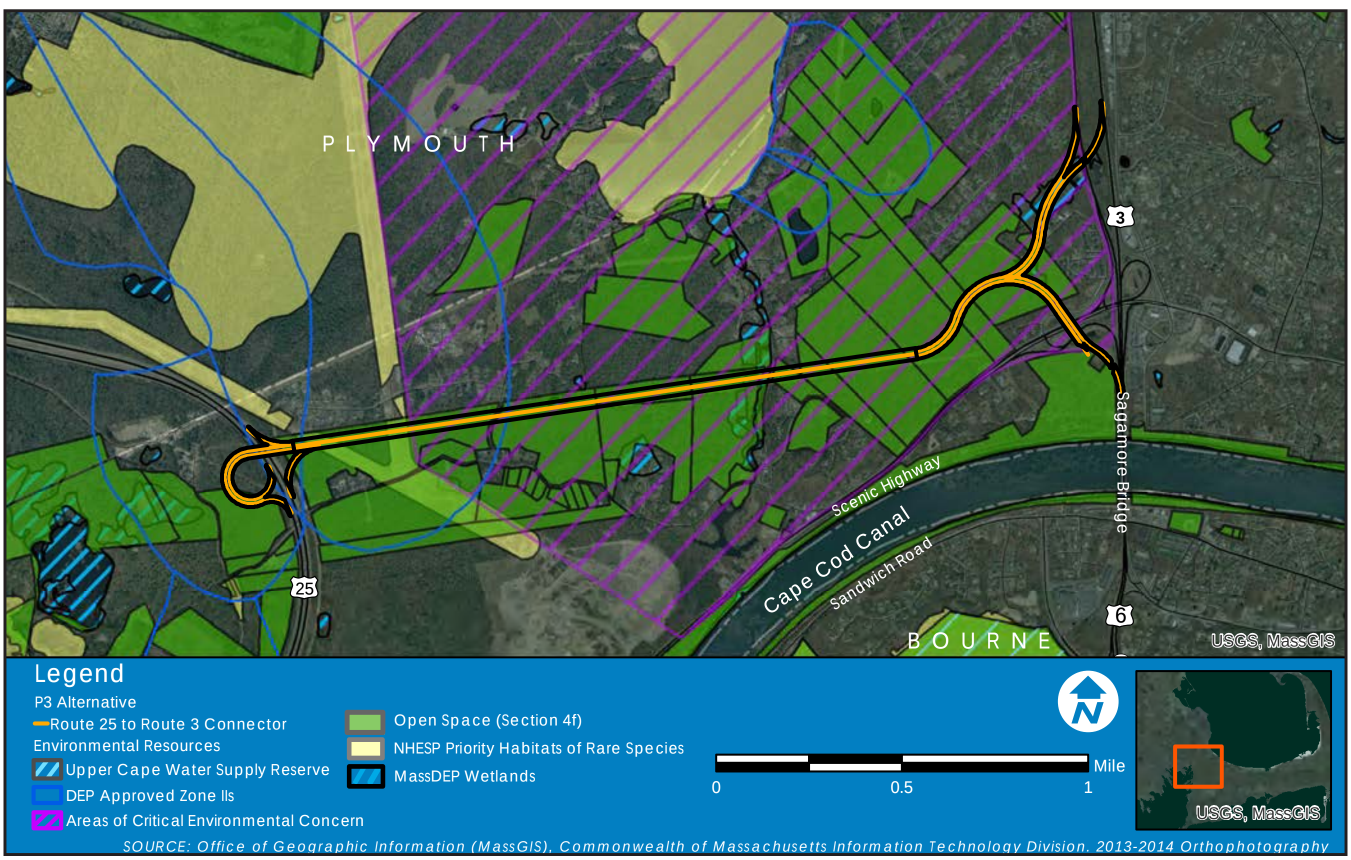


Table 4-7 Route 25 to Route 6 Connector (Mid-Canal Bridge) - Environmental Impact

| P3 ALTERNATIVE | WETLANDS | OPEN SPACE (ARTICLE 97) | ACEC | RARE SPECIES | JBCC | RESIDENTIAL PARCELS |
|---|---|---|---|---|---|---|
| | ACRES OF IMPACT (ACRES) | | | | | # OF PARCELS |
| Route 3 to Route 25 Connector | 7.2 | 53.6 | 54.7 | 51.3 | 0 | 1 |

Table 4-8 Route 25 to Route 6 Connector - Environmental Impact

| P3 ALTERNATIVE | WETLANDS | OPEN SPACE (ARTICLE 97) | ACEC | RARE SPECIES | JBCC | RESIDENTIAL PARCELS |
|---|---|---|---|---|---|---|
| | ACRES OF IMPACT (ACRES) | | | | | # OF PARCELS |
| Route 25 to Route 6 Connector | 1.2 | 37.8 | 19.2 | 63.1 | 19.9 | 17 |

area. As designated public open space protected under Article 97 of the Massachusetts Constitution, any change in the ownership or use of the Reserve would require the authorization of the Massachusetts Legislature.

### *Public-Private Partnership (P3) Alternatives Analysis Determination*

The two P3 alternatives evaluated during this study were presented at several Working Group and Public Informational meetings. The P3 alternatives included a new highway connection from Route 25 to Route 6, including a new bridge crossing of the Cape Cod Canal and a new highway connection from Route 25 to Route 3.

The reaction to these alternatives were mixed, with some people expressing strong support for these alternatives as a potentially effective means of alleviating traffic congestion. Others expressed substantial concern regarding the potential impact of these alternatives on residential neighborhoods, wetland and drinking water resources, and sensitive tribal areas. Several Working Group members noted that any construction within Joint Base Cape Cod (JBCC), particularly the portion of JBCC designated as the Upper Cape Water Reserve, would very likely be met with considerable opposition.

Based on the determination of the significant environmental impact which would not likely receive approval during the NEPA and MEPA environmental review process, and the determination that that the project's goals and objectives could be met through improvements to existing infrastructure, these two P3 alternatives were dismissed from further consideration for this study.

## 4.6 GATEWAY INTERSECTION IMPROVEMENTS

The following section describes roadway improvement alternatives at the major intersections in the focus area which provide access between the Route 3 – Route 6 corridor and the Route 25 – Route 28. These so-called 'gateway intersections' include Belmont Circle, Bourne Rotary, and Route 6 Exit 1C. The fourth gateway intersection is the Route 6 Sagamore Interchange which was reconstructed by MassDOT in 2006.

Multiple alternatives were evaluated at each of the gateway intersections to determine their effectiveness at improving traffic operations and their potential impact on environmental resources and property.

### 4.6.1 Route 6 Exit 1C Relocation

The following presents the evaluation of the relocation of Route 6 Exit 1C from its existing location at the base of the south end of the Sagamore Bridge to a point further east on Route 6.

*Existing Roadway Conditions*

Route 6 at Exit 1C (at Cranberry Highway) provides an exit and entrance on Route 6 for westbound vehicles only (Exhibit 4-11). Exit 1C is the last westbound interchange on Route 6 prior to crossing the Cape Cod Canal on the Sagamore Bridge. The geometry of Exit 1C is substandard and not in compliance with current MassDOT highway design standards. The deficiencies of Exit 1C include short acceleration and deceleration lanes, and steep grades approaching the Sagamore Bridge.

Deceleration lanes allow vehicles to safely separate from the through-travel lanes, slow down, and exit a highway at an interchange. Acceleration lanes allow vehicles to enter the highway on a separate lane, while accelerating up to highway speed before merging safely into the through-traffic lane. According to MassDOT' s Project Development and Design Guide, the desired length of a deceleration lane is 600 feet, while the desired length of an acceleration lane is 1,000 feet. At Exit 1C, these lanes are well below these desired lengths, with the existing deceleration lane approximately 300 feet long and the acceleration lane approximately 200 feet long.

Additionally, vehicles traveling west on Route 6 toward Exit 1C are on a long downgradient section (greater than one mile) of the highway. They must then quickly contend with a right-hand bend on Route 6 together with traffic entering the travel lane from Exit 1C and the steep grades (greater than six percent) on Route 6 as it approaches the Sagamore Bridge. These changes

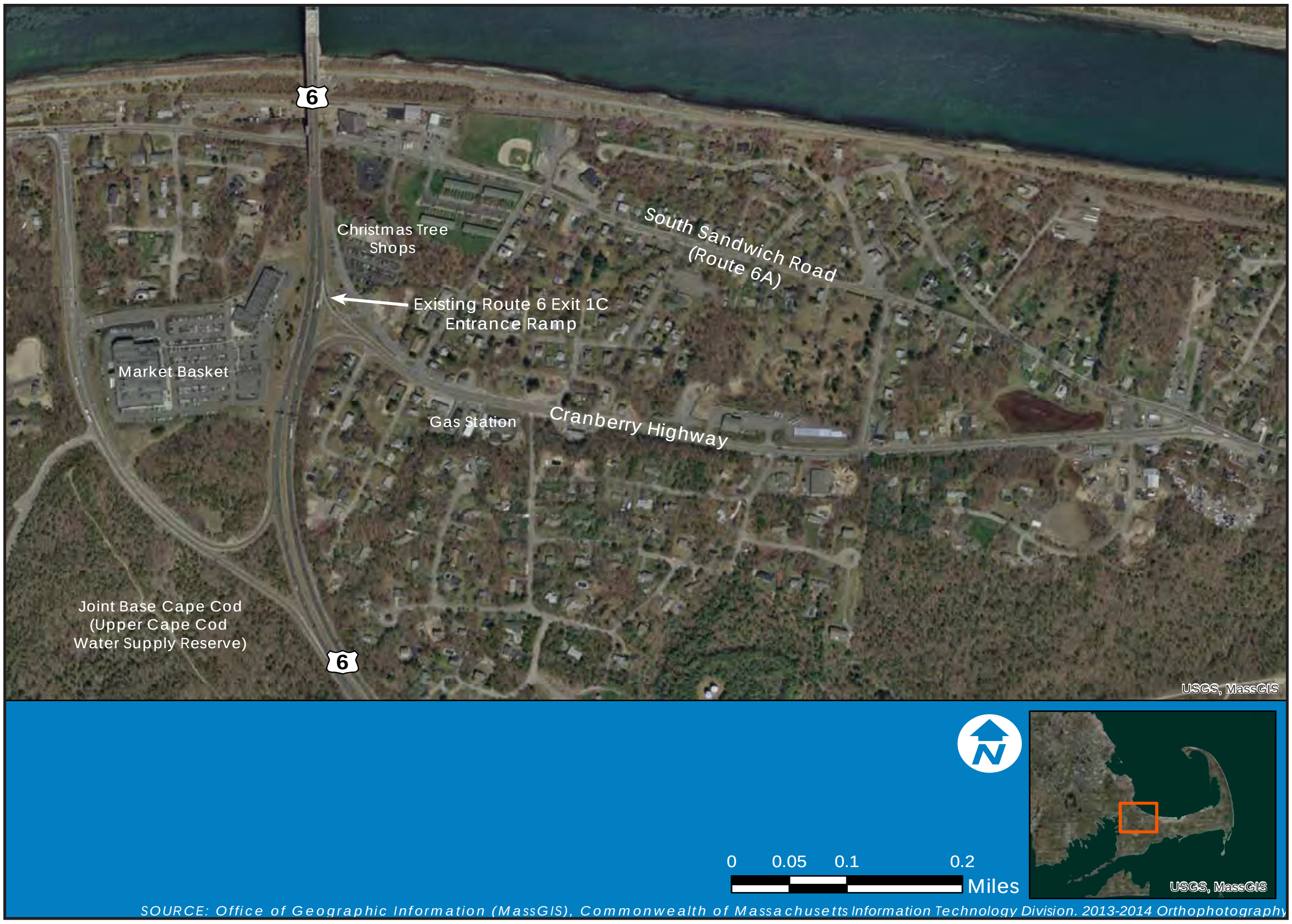



***Exhibit 4-11 Existing Conditions - Route 6 Exit 1C***

in the highway profile and the high volume of vehicles entering from Exit 1C cause substantial congestion on Route 6.

In the near-term, the relocation of Exit 1C would reduce delay by providing acceleration lanes for vehicles entering Route 6 westbound from Cranberry Highway. Additionally, it is anticipated that the future profile of a replacement Sagamore Bridge would be less steep than the six-percent grade on the existing bridge. This would result in a longer bridge, which would tie into Route 6 further east, requiring the relocation of the existing Exit 1C.

### *Land Uses and Environmental Resources*

Land uses around Exit 1C include residential properties east of Route 6 and a retail shopping plaza (including a Market Basket grocery store) on the west side of Route 6 (Exhibit 4-12). Land uses along Cranberry Highway include the Christmas Tree Shops retail store, and mix of residential, retail, restaurant, and auto-related shops. Further east, Joint Base Cape Cod abuts the west side of Route 6 from the Mid-Cape Connector interchange to Exit 2. Land use east of Route 6 includes residential

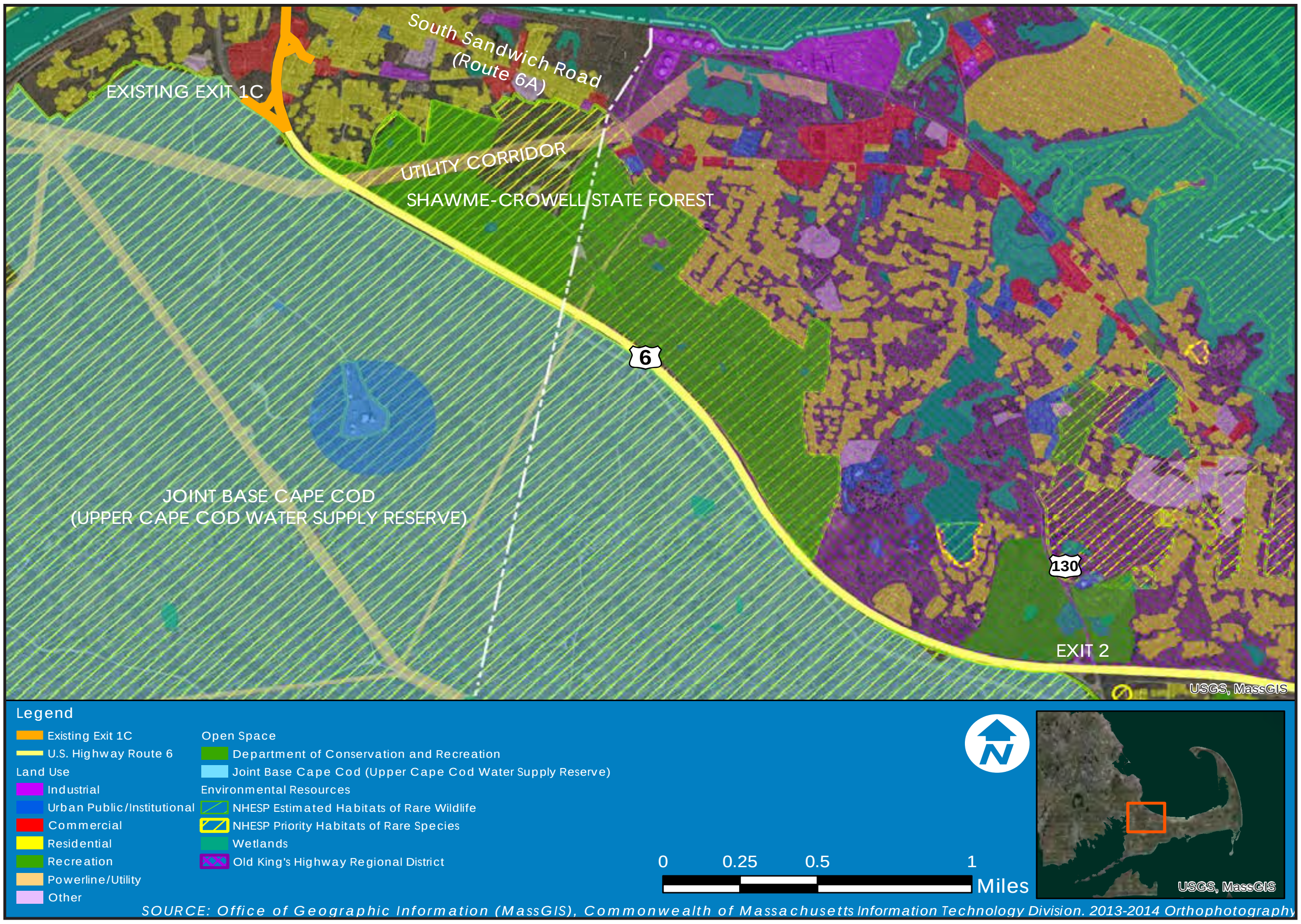



**Exhibit 4-12 Adjacent Land Uses - Route 6 Between Exit 1C and Exit 2 (Route 130)**

neighborhoods and the Shawme-Crowell State Forest (which extends nearly to Exit 2). An electrical utility corridor divides the state forest and extends 3,600 feet from Route 6 to the Route 6A at Route 130 intersection, continuing northeast approximately 3,300 feet to the Canal Electrical Generating Plant.

There are no wetlands, floodplains, or other regulated wetland resources within 100 feet of the Exit 1C interchange. The land within JBCC, the Shawme Crowell State Forest, and the utility corridor is designated by the Massachusetts Natural Heritage and Endangered Species Program as a 'Priority Habitat for Rare Species'.

### *Traffic Conditions on Route 3 / Route 6 Approaches to Sagamore Bridge*

Currently, the Route 6 westbound approach to the Sagamore Bridge at the Exit 1C interchange experiences acceptable traffic conditions (LOS A, with an average delay of five seconds) during the non-summer weekday peak period. However, conditions during summer Saturday peak periods are often characterized by substantial congestion with average queuing on Route 6

westbound extending 4.4 miles, resulting in LOS F conditions. This congestion results in substantial delays (average delay of 11.4 minutes) for vehicles heading off-Cape. The peak period delays on Route 6 westbound are forecast to increase by 2040 to 3.0- to 13.5-minutes during the non-summer and summer Saturday peak period, respectively (Table 4-9).

Existing summer Saturday peak period traffic conditions on the Route 3 southbound approach to the Sagamore Bridge are also poor with existing average delays of 6.9 minutes. These are forecast to increase to 14.8 minutes by 2040.

The location and sub-standard geometry of Exit 1C contributes to this traffic congestion. Exit 1C's short acceleration- and deceleration-lanes require vehicles to rapidly decelerate or accelerate when exiting or entering through-traffic lanes. These sudden movements cause other drivers to react by slowing down, increasing traffic congestion.

Additionally, the steep grades (greater than six percent) as Route 6 approaches the Sagamore Bridge beyond Exit 1C make it more difficult for entering vehicles to increase speed and merge into traffic.

### *Identification of Interchange Location*

Potential locations for the relocation of Exit 1C further to the east were evaluated. Relocating Exit 1C to the east would allow it to be designed in accordance with current MassDOT design standards, thereby providing a safer and smoother transition to and from Route 6. Relocating Exit 1C to the east would also be necessary to accommodate the anticipated lower profile of an assumed replacement of the Sagamore Bridge.

The selection for a new location for the Route 6 Exit 1C interchange was informed by existing land uses and compliance with Federal Highway Administration (FHWA) guidelines. As described above, the land uses adjacent to the east side of Route 6 consists of developed residential neighborhoods and state forest land (Exhibit 4-12). Additionally, in accordance with FHWA guidance, a new highway interchange should be one-mile or more from an adjacent interchange (in this case, Exit 2 at Route 130) and must provide a connection to and from an existing public street.

Given these existing constraints, the electrical utility corridor was identified as the most appropriate location for the relocated interchange. This relocated interchange would provide a roadway connection from Route 6 eastbound to the Route 6A/Route 130 intersection (Exhibits 4-13 and 4-14). This location would have

*Text continues on page 4-32.*

Table 4-9 *Traffic Operations – Route 3 / Route 6 Approaches to Sagamore Bridge*

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | FUTURE (2040) BUILD CONDITIONS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | |
| Route 3 Southbound | 11 | B | 77 | 478 | 460 (7.7) | **F** | 7,481 (1.4) | 8,476 (1.6) | 453 (7.5) | **F** | 3,534 (0.7) | 4,090 (0.8) |
| Route 6 Westbound | 5 | A | 53 | 232 | 178 (3.0) | **F** | 6,801 (1.3) | 7,967 (1.5) | 2 | A | 0 | 0 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | |
| Route 3 Southbound | 416 (6.9) | **F** | 4,823 (0.91) | 5,393 (1.02) | 887 (14.8) | **F** | 22,814 (4.3) | 24,484 (4.6) | 895 (14.9) | **F** | 23,308 (4.4) | 24,826 (4.7) |
| Route 6 Westbound | 683 (11.4) | **F** | 23,318 (4.4) | 25,014 (4.7) | 812 (13.5) | **F** | 24,825 (4.7) | 25,029 (4.7) | 210 (3.5) | **F** | 7,253 (1.4) | 10,037 (1.9) |

*Notes:*
*LOS E and LOS locations are **bold***
*LOS = Level of Service.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

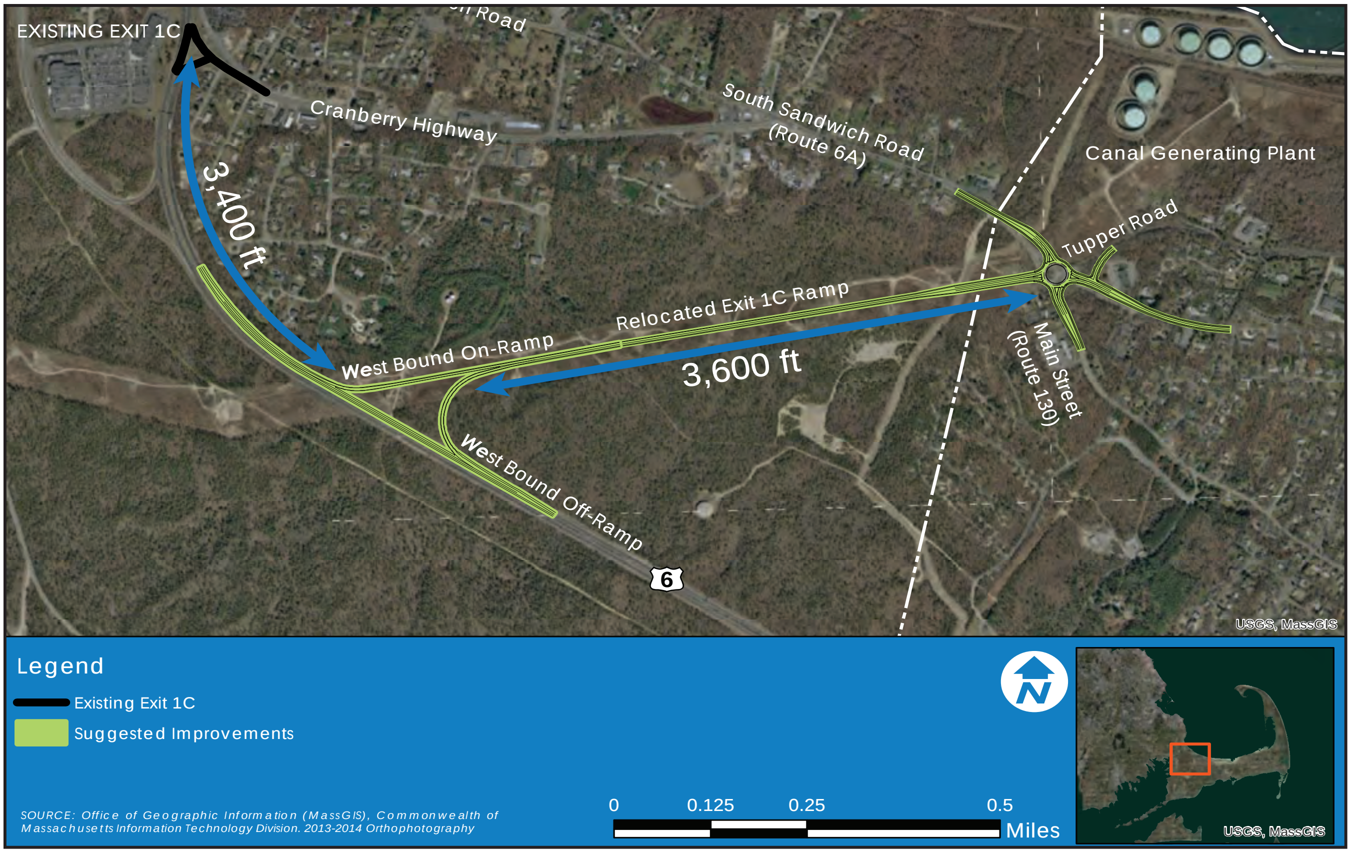



**Exhibit 4-13 Route 6 Exit 1C Relocation**

**Exhibit 4-14 Route 6 Exit 1C Ramp**

only a minor effect on existing commercial and residential properties and state forest land, is more than one mile from Exit 2, and would connect to a public street.

### *Identification of Intersection Type*

Several alternatives for incorporating the new highway ramp into the Route 6A at Route 130 intersection (Exhibit 4-15) were evaluated. These alternatives included:

- Alternative 1 – Two Signalized Intersections
- Alternative 2 – Four-Leg Roundabout
- Alternative 3 – Five-Leg Roundabout

### *Traffic Operations at Route 6A/Route 130 Intersection*

During existing and future no-build peak periods, traffic operates acceptably at the existing unsignalized intersection of Route 6A at Route 130 intersection (LOS A and B) except for the Route 6A eastbound approach, which operates at LOS F during the summer for both the existing and future peak periods. During the summer Saturday peak period, the Route

***Exhibit 4-15 Route 6 Exit 1C - Route 6A Intersection Alternatives***

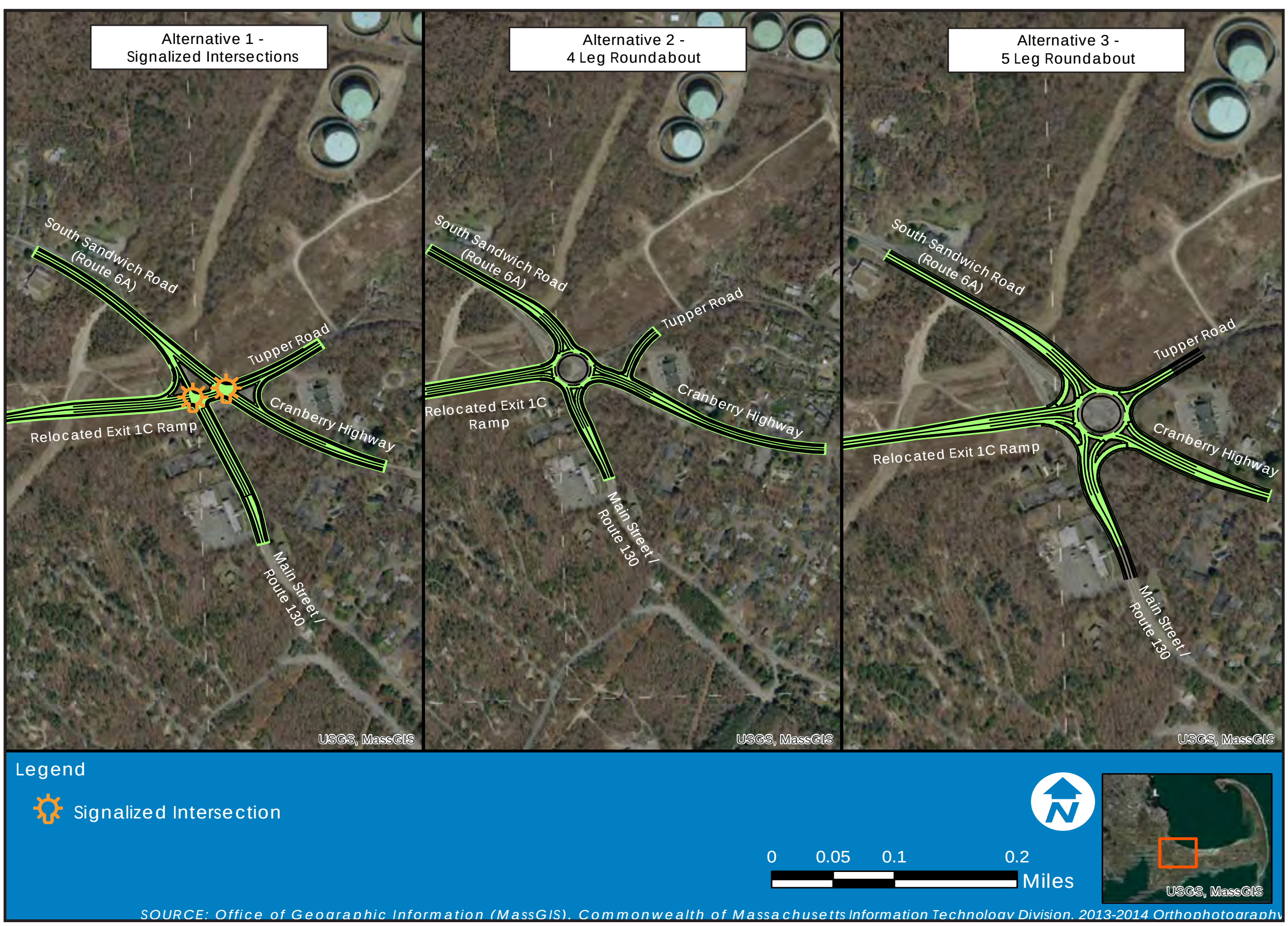


Table 4-10 Traffic Operations – Existing and Future No-Build Conditions, Route 6A at Route 130

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | |
|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | |
| Route 6A EB Lt/Th/Rt | 32 | D | 0.52 | 70 | 74 | **F** | 0.83 | 151 |
| Route 6A WB Lt/Th/Rt | 11 | B | 0.17 | 16 | 12 | B | 0.21 | 19 |
| Route 130 NB Lt/Th/Rt | 2 | A | 0.06 | 5 | 2 | A | 0.08 | 6 |
| Tupper Road WB Lt/Th/Rt | 0.2 | A | 0 | 0 | 0.1 | A | 0 | 0 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | |
| Route 6A EB Lt/Th/Rt | n/a | **F** | 5.62 | n/a | n/a | **F** | 24.15 | n/a |
| Route 6A WB Lt/Th/Rt | 30 | D | 0.69 | 128 | 703 (11.7) | **F** | 0.94 | 251 |
| Route 130 NB Lt/Th/Rt | 3 | A | 0.11 | 9 | 4 | A | 0.16 | 14 |
| Tupper Road WB Lt/Th/Rt | 0.1 | A | 0 | 0 | 0.1 | A | 0 | 0 |

*Notes:*
*•LOS E and LOS F movements are **bold***
*•Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*•LOS = Level of Service; V/C = Volume to Capacity Ratio*
*•Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*•n/a = Volume exceeds capacity to the point where the respective value cannot be determined.*

6A westbound approach operates at LOS F/D under existing and future no-build conditions, respectively (Table 4-10).

### *Future Traffic Operations at new intersection of the Route 6 Exit 1C Ramp at Route 6A and Route 130*

Traffic operations at the new intersection consisting of the Exit 1C ramp, Route 6A and Route 130 under the three different intersection alternatives was evaluated. The results of this analysis for these three different intersection alternatives are summarized below on Table 4-11(Alternative 1 - Two Signalized Intersections) and Table 4-12 (Alternatives 2 and 3, Four-Leg and Five-Leg Roundabouts).

Overall, Alternative 1 would operate at LOS B during the non-summer weekday peak period and LOS F during the summer Saturday peak period. However, at 152 and 206 seconds, the average delay during the summer Saturday peak period is longer than the summer Saturday peak period delay for either roundabout alternative.

Under the future build conditions, Alternative 2, the Four-Leg Roundabout, and Alternative 3, the Five-Leg Roundabout, would operate similarly. During the non-summer weekday peak period, the LOS for each approach to the roundabout would range from LOS A to LOS D, with delays ranging from eight to 27 seconds. During the summer Saturday peak period, the delays at the approaches to both roundabout alternatives would range from nine- to 213 seconds.

Table 4-11 Traffic Operations – Exit 1C Ramp at Route 6A/Route. 130, Two Signalized Intersection Alternative

| ALTERNATIVE 1 - INTERSECTION 1 ROUTE 6 EXIT 1C RAMP AT ROUTE 6A AND TUPPER RD | FUTURE (2040) BUILD CONDITIONS - INITIAL SCREENING | | | | |
|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 50% QUEUE *Feet (Miles)* | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | |
| Route 6A (Sandwich Rd) SB Lt | 18 | B | 0.14 | 14 | 36 |
| Route 6A (Sandwich Rd) SB Th/Rt | 19 | B | 0.35 | 54 | 99 |
| Route 6A NB Lt | 27 | C | 0.71 | 80 | 149 |
| Route 6A SB Th/Rt | 18 | B | 0.27 | 41 | 79 |
| Exit1C Off Ramp Connector Rd EB Lt | 9 | A | 0.8 | 22 | 323 |
| Exit1C Off Ramp Connector Rd EB Lt/Th/Rt | 7 | A | 0.74 | 10 | 65 |
| Tupper Road WB Lt/Th/Rt | 43 | D | 0.71 | 41 | 140 |
| **Intersection (Overall)** | **15.5** | **B** | **0.75** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | |
| Route 6A (Sandwich Rd) SB Lt | 28 | C | 0.39 | 51 | 102 |
| Route 6A (Sandwich Rd) SB Th/Rt | 30 | C | 0.56 | 229 | 330 |
| Route 6A NB Lt | 505 (8.4) | **F** | 2.01 | 605 | 816 |
| Route 6A SB Th/Rt | 31 | C | 0.58 | 247 | 352 |
| Exit1C Off Ramp Connector Rd EB Lt | 17 | B | 0.82 | 64 | 567 |
| Exit1C Off Ramp Connector Rd EB Lt/Th/Rt | 14 | B | 0.8 | 51 | 88 |
| Tupper Road WB Lt/Th/Rt | 356 (5.9) | **F** | 1.62 | 359 | 550 |
| **Intersection (Overall)** | **151.9** | **F** | **1.45** | | |

| ALTERNATIVE 1 - INTERSECTION 2 ROUTE 130 AT EXIT 1C CONNECTOR RAMP | FUTURE (2040) BUILD CONDITIONS - INITIAL SCREENING | | | | |
|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 50% QUEUE *Feet (Miles)* | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | |
| Route 130 (Main Street) (NB) Lt | 18 | B | 0.27 | 27 | 60 |
| Route 130 (Main Street) (NB) Rt | 17 | B | 0.04 | 0 | 8 |
| Route 6A SB Th | 18 | B | 0.24 | 37 | 72 |
| Route 6A SB Rt | 18 | B | 0.28 | 0 | 56 |
| Exit1C Off Ramp EB Th/Rt | 20 | C | 0.77 | 177 | 323 |
| Exit1C Off Ramp Connector Rd WB Lt/Th | 14 | B | 0.32 | 108 | 221 |
| **Intersection (Overall)** | **18.5** | **B** | **0.56** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | |
| Route 130 (Main Street) (NB) Lt | 30 | C | 0.51 | 141 | 223 |
| Route 130 (Main Street) (NB) Rt | 24 | C | 0.12 | 0 | 47 |
| Route 6A SB Th | 25 | C | 0.18 | 67 | 113 |
| Route 6A SB Rt | 26 | C | 0.3 | 51 | 125 |
| Exit1C Off Ramp EB Th/Rt | 33 | C | 0.69 | 303 | 377 |
| Exit1C Off Ramp Connector Rd WB Lt/Th | 605 (10) | **F** | 2.23 | 1008 | 504 |
| **Intersection (Overall)** | **206.1 (3.4)** | **F** | **1.59** | | |

*Notes:*
*LOS E and LOS F movements are **bold***
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB- Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

Table 4-12 Exit 1C Ramp at Route 6A and Route 130, Roundabout Alternatives

| ROUTE 6 EXIT 1C RAMP AT ROUTE 6A AND ROUTE 130 | ALTERNATIVE 2 – 4 LEG ROUNDABOUT | | | | ALTERNATIVE 3 – 5 LEG ROUNDABOUT | | | |
|---|---|---|---|---|---|---|---|---|
| | FUTURE (2040) BUILD CONDITIONS - SCREENING ANALYSIS | | | | | | | |
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | |
| Exit 1C Ramp (EB) Lt | 27 | D | 0.85 | 10 | 27 | D | 0.85 | 10 |
| Exit 1C Ramp (EB) Th/Rt | 9 | A | 0.37 | 2 | 8 | A | 0.37 | 2 |
| Route 6A (WB) Lt/Th | 17 | C | 0.56 | 3 | 14 | B | 0.44 | 2 |
| Route 6A (WB) Rt | 10 | B | 0.32 | 1 | 10 | A | 0.25 | 1 |
| Route 130 (NB) Lt/Th | 13 | B | 0.32 | 1 | 13 | B | 0.32 | 1 |
| Route 130 (NB) Rt | 8 | A | 0.03 | 0 | 8 | A | 0.03 | 0 |
| Route 6A (Sandwich Rd) SB Lt/Th | 10 | B | 0.44 | 2 | 8 | A | 0.28 | 1 |
| Route 6A (Sandwich Rd) SB Rt | 12 | B | 0.54 | 3 | 6 | A | 0.15 | 1 |
| Tupper Road WB Lt/Th/Rt | | | | | 13 | B | 0.31 | 1 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | |
| Exit 1C Ramp (EB) Lt | 54 | F | 0.98 | 15 | 55 | F | 0.98 | 15 |
| Exit 1C Ramp (EB) Th/Rt | 9 | A | 0.32 | 1 | 9 | A | 0.32 | 1 |
| Route 6A (WB) Lt/Th | 213 (3.6) | F | 1.39 | 32 | 112 (1.9) | F | 1.13 | 18 |
| Route 6A (WB) Rt | 73 (1.2) | F | 1.02 | 15 | 44 | E | 0.86 | 9 |
| Route 130 (NB) Lt/Th | 48 | E | 0.87 | 9 | 48 | E | 0.87 | 9 |
| Route 130 (NB) Rt | 9 | A | 0.11 | 0 | 9 | A | 0.11 | 0 |
| Route 6A (Sandwich Rd) SB Lt/Th | 105 (1.8) | F | 1.13 | 20 | 26 | D | 0.73 | 6 |
| Route 6A (Sandwich Rd) SB Rt | 16 | C | 0.53 | 3 | 12 | B | 0.38 | 2 |
| Tupper Road WB Lt/Th/Rt | | | | | 171 (2.9) | F | 1.23 | 16 |

*Notes:*
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and delay not calculated for unsignalized intersections*
*Shaded areas do not exist in listed configuration during this period*

## *Future Traffic Operations along Route 3 and Route 6 Approaches to Sagamore Bridge*

With a relocated Route 6 Exit 1C in place, queuing and delays in the future (2040) would be substantially reduced for vehicles heading off-Cape on Route 6 westbound during both the non-summer weekday PM and summer Saturday peak periods (Table 4-9). For example, the future summer Saturday peak period delay would be reduced from 13.5 minutes to 3.5 minutes. During the non-summer weekday peak period, delay would be reduced from 3.0 minutes to 0.0 minutes. Delay on Route 3 southbound would not be reduced with the relocation of Exit 1C.

For this screening analysis stage, it is assumed that the existing Canal bridges remain. More detailed information on results of the future traffic operations on Route 6 westbound with the relocated Exit 1C in place is discussed under Travel Demand Model Case 1 and Case 3A (Section 4.8).

### *Property or Environmental Resource Impact*

The relocation of Exit 1C would require the use of approximately 3.8 acres of land owned by the utility provider, Eversource, either as a land acquisition or a permanent easement. The improvements may also require the acquisition of approximately 0.15 acres of residential property and approximately 0.9-acres of commercial property at the Route 6A (Sandwich Road) at Route 130 intersection (Table 4-13).

No wetland, floodplain, or other regulated water resources would be impacted. These improvements would impact approximately 7.2 acres of land designated as a 'Priority Habitat for Rare Species'.

*Table 4-13 Potential Environmental Impact - Exit 1C Ramp at Route 6 and Route 130*

| | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 |
|---|---|---|---|
| RESOURCE AREAS (ACRES): | | | |
| Rare Species Habitat | 7.4 | 7.2 | 7.0 |
| OPEN SPACE (ACRES): | | | |
| DCR - Shawme-Crowell State Forest | 0.5 | 0.6 | 0.5 |
| Interim Wellhead Protection Area (IWPA) | 4.6 | 5.7 | 5.5 |
| RIGHT OF WAY (ACRES): | | | |
| Residential | 0.02 | 0.15 | 0.03 |
| Commercial | 0.02 | 0.9 | 0.26 |
| Utility | 3.5 | 3.8 | 3.8 |

*Notes:*
*Environmental and right-of-way impact based on conceptual design and GIS-based data.*

### *Suggested Alternative*

The suggested alternative involves the relocation of Route 6 Exit 1C interchange approximately 3,400 feet to the east (Exhibit 4-13). A relocated highway interchange would be constructed on Route 6 providing westbound-only access (the Mid-Cape Connector provides eastbound access to Route 6). The new interchange ramp would extend approximately 3,600 feet within the electrical utility corridor to the Route 6A (Sandwich Road) and Route 130 intersection (Exhibit 4-16).

Alternative 2 – Relocated Interchange with Four-Leg Roundabout – was advanced for further study during the travel demand model analysis. This alternative was selected because it would provide better traffic operations at the Route 6A/Route 130 intersection (when compared to Alternative 1). Furthermore, when compared to the larger Five-Leg Roundabout featured in Alternative 3, the

Four-Leg Roundabout was considered a simpler design and more in line with the community context. Environmental impacts were approximately the same for all alternatives.

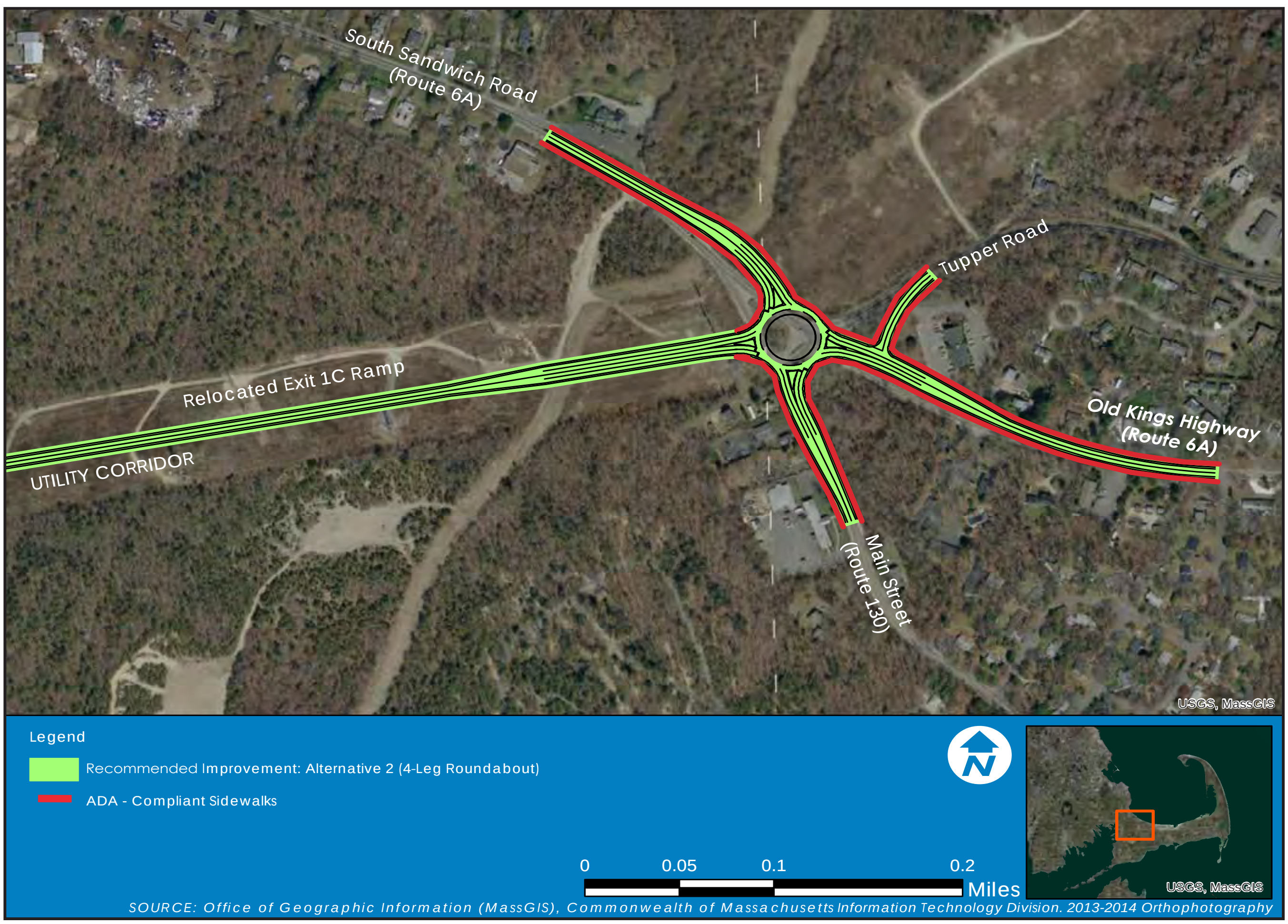
### *Conceptual Cost Estimate*

The conceptual cost estimates for the three alternatives to relocate the Route 6 Exit 1C interchange are provided by construction year in Table 4-14. More detailed conceptual cost estimates are provided in Appendix E.

*Table 4-14 Relocation of Route 6 Exit 1C, Conceptual Cost Estimate*

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Alternative 1 | 27 | 45 | 67 |
| Alternative 2 (suggested alternative) | 30 | 51 | 75 |
| Alternative 3 | 28 | 47 | 69 |

***Exhibit 4-16 Route 6 Exit 1C at Route 6A/Route 130 Intersection – Suggested Alternative***



### 4.6.2 Route 6 Additional Eastbound Travel Lane

The construction of an additional travel lane on Route 6 eastbound for approximately 3.4 miles from the Mid-Cape Connector to Exit 2 (Route 130) was evaluated. It is assumed that this additional travel lane would be constructed concurrent with the construction of a replacement Sagamore Bridge. A replacement Sagamore Bridge in envisioned to include auxiliary lanes extending from the Scenic Highway entrance ramp to Route 3 southbound, over the Sagamore Bridge, to the Mid-Cape Connector entrance ramp to Route 6 eastbound.

An additional eastbound travel lane on Route 6 would act an extension of this auxiliary lane providing additional capacity and distance for entering vehicles to merge onto the heavily-traveled section of Route 6 eastbound between the Sagamore Bridge and Exit 2 (Route 130). The extension of this additional eastbound travel lane is not required beyond Exit 2 because traffic volumes drop substantially after this point. For example, during the future no-build period, traffic volumes west of Exit 2 drop by more than 27%, from 2,765 to 2,000 vehicles, during the non-summer weekday PM peak period.

#### *Existing Conditions*

Currently, Route 6 between the Mid-Cape Connector and Exit 2 (Route 130) consists of two 12-foot wide travel lanes in each direction separated by a 30-foot wide grassed median. An eight-foot wide gravel shoulder abuts the right travel lane in each direction.

Route 6 eastbound currently operates at LOS C during the non-summer weekday peak period and LOS D during the summer Saturday peak period. This degrades to LOS D and LOS E in 2040.

#### *Land Uses and Environmental Resources*

Land uses in the area include approximately 100 residential properties east of Route 6, with access to Cranberry Highway at Exit 1C. Other than a utility corridor and a small residential development south of Shawme Lake, land uses adjacent to Route 6 for the remainder of the corridor consist of undeveloped forest within Joint Base Cape Cod west of Route 6 and the Shawme-Crowell State Forest east of Route 6 (Exhibit 4-17).

There are no wetlands, floodplains, or other regulated wetland resources within 100 feet of the Route 6 corridor. The forested land within Joint Base Cape Cod and the Shawme-Crowell State Forest is designated by the Massachusetts Natural Heritage and Endangered Species Program as a ‘Priority Habitat for Rare Species’.

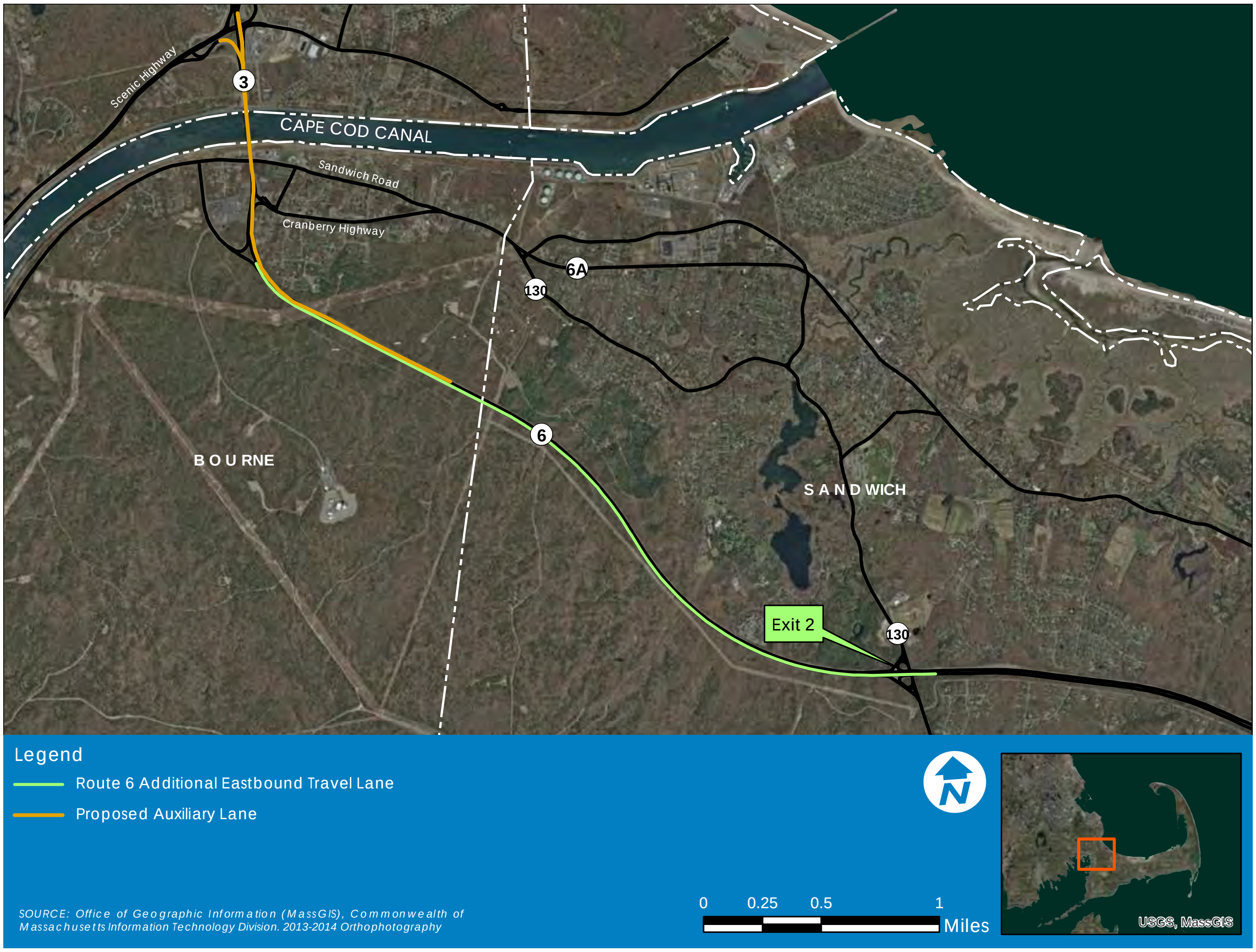



***Exhibit 4-17 Route 6 - Additional Eastbound Travel Lane and Westbound Auxiliary Lane***

## *Suggested Improvements*

Suggested improvements on Route 6 involve the construction of an additional travel lane on Route 6 eastbound for approximately 3.4 miles from the Mid-Cape Connector to Exit 2 at Route 130 (Exhibit 4-17).

The effect of the relocation of Exit 1C on queuing on Route 6 is provided in Section 4.8; under Case 1 for the existing Canal bridge condition and under Case 3A for the replacement Canal bridge condition.

## *Property or Environmental Resource Impact*

These improvements could be constructed entirely within the MassDOT right-of-way, with no property acquisitions required. The work may impact up to 3.9 acres of rare species habitat. No other regulated environmental resources, such as wetlands or floodplains, would be impacted.

### *Conceptual Cost Estimate*

The conceptual cost of the additional Route 6 eastbound travel lane is provided by construction year in Table 4-15. More detailed conceptual cost estimates are provided in Appendix E.

*Table 4-15 Route 6 Eastbound Travel Lane - Conceptual Cost Estimate by Build Year*

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Route 6 Eastbound Travel Lane | 29 | 48 | 71 |

## 4.6.3 Belmont Circle and Bourne Rotary – Introduction

Belmont Circle and the Bourne Rotary, located north and south of the Bourne Bridge, respectively, are two of the most critical intersections in the study area. Motorists often must navigate both traffic circles when traveling through Bourne and when crossing the Bourne Bridge. Belmont Circle is the intersection of Route 25, Main Street, Scenic Highway, and the Buzzards Bay Bypass. Bourne Rotary processes vehicles from Route 28, Sandwich Road, and Trowbridge Road.

From the west, access to the Bourne Bridge is provided on Route 25. To avoid traffic congestion on Route 25 eastbound while heading toward the Bourne Bridge, travelers often leave Route 25 at Exit 2 (Glen Chen Charlie Road) to access Route 6 eastbound in Wareham towards Main Street and Belmont Circle in Bourne. A strong traveler preference for Main Street eastbound rather than the parallel route of the Buzzards Bay Bypass has been observed.

The existing land uses and environmental resources at Belmont Circle and Bourne Rotary, presented in Chapter 2 (Section 2.2.3), informed the constraints on the potential transportation improvements in these areas. In developing improvement alternatives, avoiding impact to property and environmental resources was prioritized.

The high traffic volumes and sub-standard design of these unsignalized traffic circles result in severe traffic congestion during peak periods. Each operate at LOS F during all peak travel period during the non-summer weekday and summer Saturday peak periods resulting in lengthy queues of vehicles extending from the approaches to both Belmont Circle and the Bourne Rotary. The existing and future traffic operations at Belmont Circle and Bourne Rotary are described in Chapters 2 and 3 (Sections 2.5.10 and 3.3.7).

Further, the proximity of these traffic circles to one another results in their having a substantial effect on each another. For example, during peak periods the traffic queuing on Route 28 southbound extends over the Bourne Bridge, and several thousand feet north along Route 25. These queues in turn delay other motorists trying to enter Belmont Circle from Route 25 Exit 3 or Scenic Highway.

The key to improving traffic operations at both Belmont Circle and Bourne Rotary was identifying transportation improvements that:

1. Reduce traffic volumes entering the Belmont Circle and Bourne Rotary;
2. Safely accommodate both regional and local traffic;
3. Maintain access to local businesses; and
4. Ensure compatibility with a future replacement Bourne Bridge alignment (assumed to the east of the existing bridge).

Transportation improvements at Belmont Circle and Bourne Rotary (and the other problem intersections in the study area) is the most important factor in minimizing diversions of regional traffic diversions to local roadways.

The following sections describe the transportation improvements alternatives at Belmont Circle and Bourne Rotary that were evaluated by the study team, in conjunction with the study Working Group.

### 4.6.4 Belmont Circle

As described below, several alternatives were evaluated to improve traffic operations at Belmont Circle. To provide the context of Belmont Circle, Exhibit 4-18 presents the existing roadways at Belmont Circle. These alternatives were conceived to be compatible with the existing Bourne Bridge as well as with the vertical and horizontal alignment of an assumed replacement of the Bourne Bridge. The traffic analysis is based on location and geometry of the existing Bourne Bridge.

#### *Suggested Improvement – New Entrance Ramp, Scenic Highway Westbound to Route 25 Westbound*

Currently, vehicles traveling from the east on Scenic Highway heading for Route 25 enter the east side of Belmont Circle and then immediately exit onto the Route 25 entrance ramps. This roadway configuration contributes to congestion in Belmont Circle because it requires vehicles to enter Belmont Circle when their destination is Route 25.


***Exhibit 4-18 Belmont Circle - Existing Conditions***

As noted previously, one key to improving traffic operations at Belmont Circle is to reduce traffic volumes entering the Circle. To achieve this goal, roadway improvements were evaluated involving the construction of a new highway entrance ramp from Scenic Highway westbound to Route 25 westbound (Exhibit 4-19). The Scenic Highway at Nightingale Pond Road intersection would be reconstructed to accommodate this new ramp. This new ramp would divert vehicles from entering Belmont Circle from Route 25 eastbound before they entered Belmont Circle.

### *Traffic Analysis*

A new Scenic Highway to Route 25 westbound entrance ramp would achieve the goal of reducing traffic volumes entering Belmont Circle by diverting approximately 40% of vehicles on Scenic Highway westbound to this new Route 25 westbound ramp. Specifically, during peak periods this ramp would result in the diversion from Belmont Circle 680 of 1,605 vehicles (non-summer weekday PM) and 875 of 2,095 vehicles (summer Saturday).

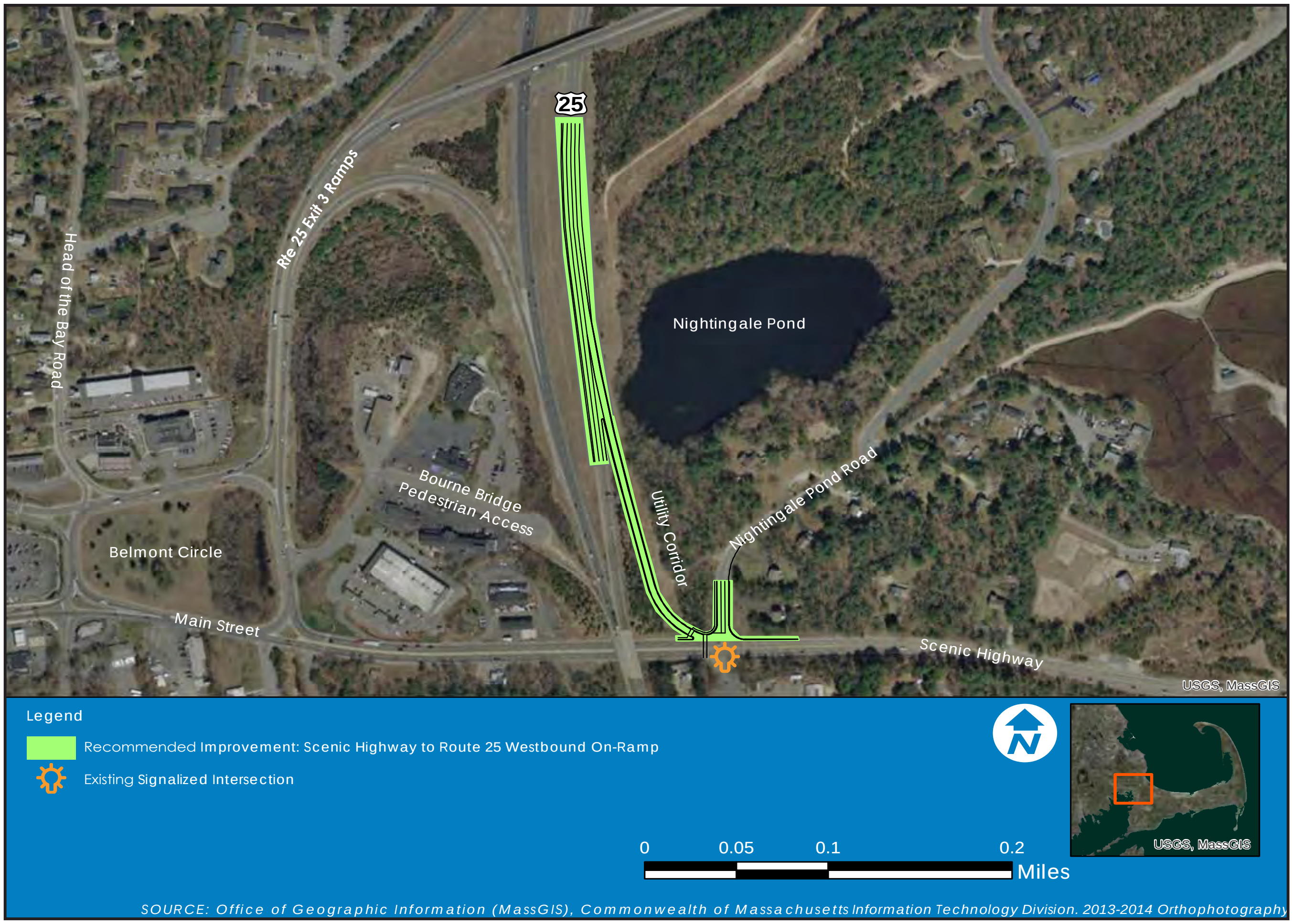



***Exhibit 4-19 Suggested Improvements - Scenic Highway Westbound to Route 25 Westbound Ramp***

These improvements would result in a reduction in the length of queues on the Scenic Highway westbound approach to Belmont Circle during both the non-summer weekday and summer Saturday peak periods. During the summer Saturday peak period, other approaches to Belmont Circle would not experience a notable reduction in queuing or delays (Table 4-16).

### *Environmental Resource/Utility Impact*

A Route 25 westbound entrance ramp from Scenic Highway would result in approximately 0.2 acres of impact to land within an interim wellhead protection area. No wetland, floodplain, or rare species habitat areas would be impacted (Table 4-20).

This ramp would be partially within an area containing natural gas lines, requiring close coordination with the utility company to determine if relocation of these gas lines would be necessary.

*Table 4-16 Scenic Highway to Route 25 WB Ramp - Traffic Operations at Belmont Circle*

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 65 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.3) | **F** | 1,780 | 35 | D | 520 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 85 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 27 | D | 1,085 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 1 | A | 60 |
| **Intersection (Overall)** | **8.6** | **A** | | **73** | **F** | | **13.4** | **B** | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 2 | A | 280 |
| Head of Bay Rd SB | 83 (1.4) | **F** | 570 | 656 (11.0) | **F** | 2,700 (0.51) | 451 (7.5) | **F** | 2,100 |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 12 | B | 305 |
| Main Street EB | 82 (1.4) | **F** | 5,755 (1.1) | 126 (2.1) | **F** | 6,140 (1.2) | 185 (3.1) | **F** | 6,140 (1.2) |
| Scenic Highway WB | 125 (2.1) | **F** | 10,605 (2.0) | 161 (2.7) | **F** | 11,610 (2.2) | 154 (2.6) | **F** | 10,630 (2.2) |
| **Intersection (Overall)** | **62.6 (1.0)** | F | | **191.4 (3.2)** | F | | **160.8 (2.7)** | F | |

*Notes:*
*LOS E and Los F movements are shaded **bold***
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

*Table 4-17 Scenic Highway to Route 25 WB Ramp – Conceptual Cost Estimate*

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Scenic Highway to Route 25 WB Ramp | 7 | 11 | 16 |

## Conceptual Cost Estimate

The conceptual cost estimate for the Route 25 entrance ramp from Scenic Highway is provided by construction year in Table 4-17. More detailed conceptual cost estimates are provided in Appendix E.

## Belmont Circle Reconstruction – Alternatives Evaluated

Several alternatives to improve traffic operations at Belmont Circle were evaluated. These alternatives each incorporate the construction of the Route 25 westbound entrance ramp from Scenic Highway.

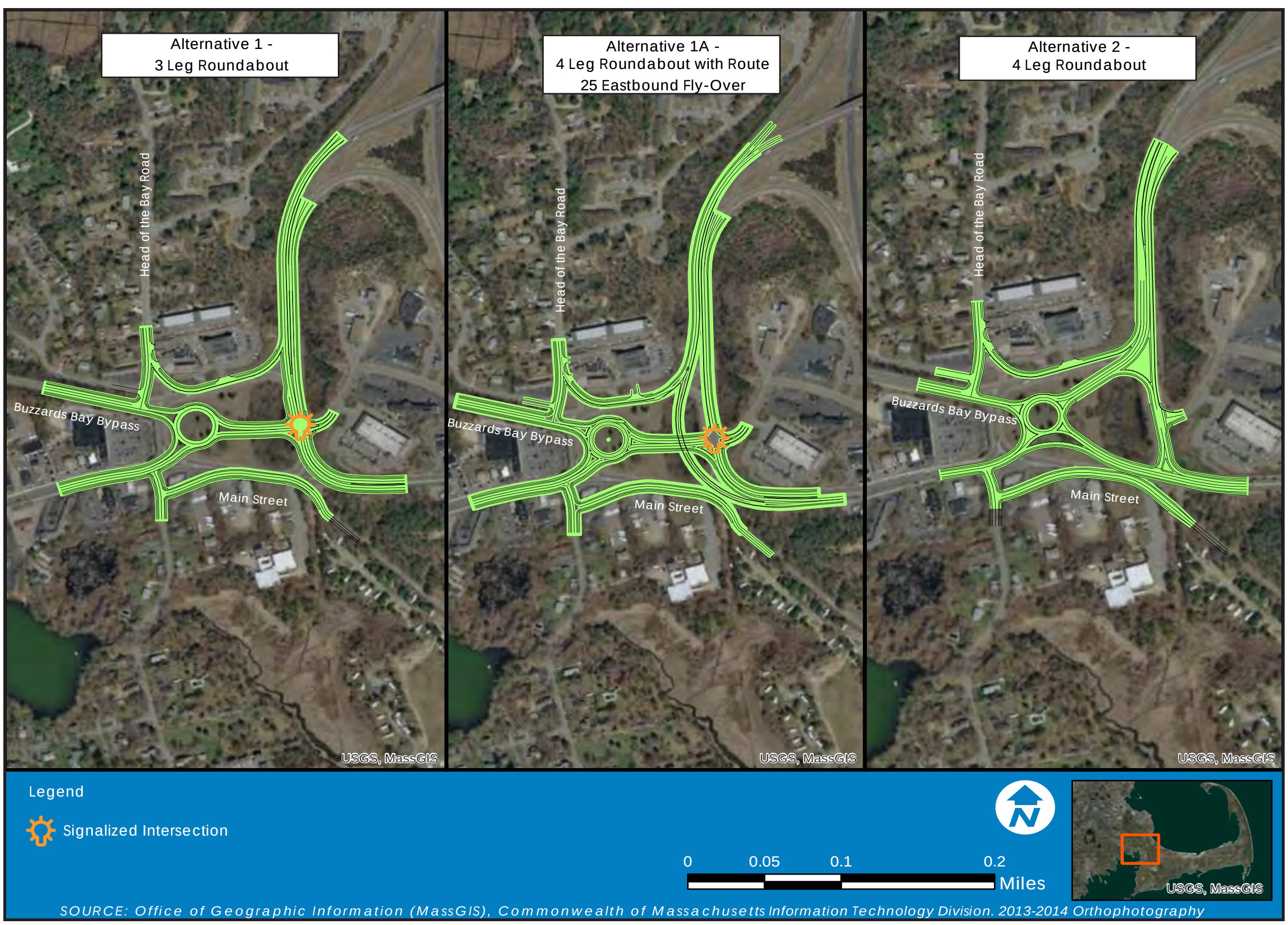
All alternatives would include improvements for bicycle and pedestrian accommodations and maintain access to adjacent properties. Sidewalks, crosswalks, and bicycle lanes would be constructed to provide access between businesses and residential areas west of Belmont Circle in Bourne and Scenic Highway, the Canal bike trail and the Bourne Scenic Park Campground.

As shown on Exhibit 4-20, three alternatives were advanced for analysis. These alternatives included:

*Alternative 1 - Three-Leg Roundabout with Signalized Intersection*

Alternative 1 involves the construction of a three-leg roundabout (approximately 200 feet in diameter) within the existing Belmont Circle infield with legs of the roundabout for Main Street, Buzzards Bay Bypass, and a new connector roadway from a new signalized intersection on the eastern side of the Circle. This new intersection would accommodate vehicles from Scenic Highway and the Route 25 Exit 3 ramps.

**Exhibit 4-20 Alternatives Evaluated - Belmont Circle**



*Alternative 1A – Three-Leg Roundabout with Signalized Intersection and Flyover Ramp*

Alternative 1A is similar to Alternative 1 in that it involves the construction of a three-leg roundabout within the existing Belmont Circle infield with legs of the roundabout for Main Street, Buzzards Bay Bypass, and an approach roadway from a new signalized intersection on the eastern side of the Circle. Alternative 1A differs with the addition of a ramp directly from the Route 25 Exit 3 off-ramp to Scenic Highway eastbound. This ramp would pass directly over the roundabout eastern approach road (on a new bridge). Vehicles with destinations other than eastbound on Scenic Highway would use the separate ramp to access Head of the Bay Road or use the new signalized intersection to access the roundabout.

*Alternative 2 – Four-Leg Roundabout*

Alternative 2 involves the construction of a four-leg roundabout (approximately 200 feet in diameter) within the existing Belmont Circle infield. The legs of the roundabout would include Main Street, Buzzards Bay Bypass, Scenic Highway, and the Route 25 Exit 3 ramps. Vehicles destined for Head of the Bay Road from this Route 25 off-ramp would use a separate ramp.

### Traffic Analysis

A traffic analysis was completed of the three alternatives developed for Belmont Circle. The results of this analysis are summarized below and shown on Table 4-18. A comparison of the maximum peak period queue lengths for the approaches to Belmont Circle for the existing, future no-build and the three alternatives are provided in Table 4-19. The existing and future no-build traffic conditions at Belmont Circle are provided in Section 3.3.7.

*Alternative 1 (Three-Leg Roundabout with Signalized Intersection)*

The approaches to the Belmont Circle roundabout would operate within the range of LOS A to E, with average delay ranging from nine to 42 seconds. In comparison, Belmont Circle would operate at LOS F during both the non-summer weekday and summer Saturday peak period under the future no-build condition.

At 42- and 272-seconds during the non-summer weekday and summer Saturday peak periods, respectfully, the Main Street approach to the Circle would have the longest delays. Other than the Roundabout Connector (1.7 minutes) during the summer Saturday peak period, all other average delays are less than one minute.

Table 4-18 *Belmont Circle Reconstruction, Traffic Operations - Comparison of Alternatives*

| | ALTERNATIVE 1 (RECOMMENDED) | | | | ALTERNATIVE 1A | | | | ALTERNATIVE 2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FUTURE (2040) BUILD CONDITIONS - SCREENING ANALYSIS | | | | | | | | | | | |
| | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | V/C | 95% QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | |
| Buzzards Bay (EB) Lt/Th | 16 | C | 0.64 | 5 | 16 | C | 0.64 | 5 | 89 (1.5) | **F** | 1.06 | 15 |
| Buzzards Bay (EB) Rt | 6 | A | 0.16 | 1 | 6 | A | 0.16 | 1 | 7 | A | 0.17 | 1 |
| Roundabout Conn. (WB) Lt | 11 | B | 0.52 | 3 | 11 | B | 0.52 | 3 | | | | |
| Roundabout Conn. (WB) Th/Rt | 11 | B | 0.51 | 3 | 11 | B | 0.51 | 3 | | | | |
| Main Street (NB) Lt | 9 | A | 0.35 | 2 | 9 | A | 0.35 | 2 | | | | |
| Main Street (NB) Th/Rt | 42 | **E** | 0.93 | 13 | 42 | **E** | 0.93 | 13 | | | | |
| Main Street (NB) Lt/Th/Rt | | | | | | | | | 188 (3.1) | **F** | 1.33 | 26 |
| Scenic Highway (WB) Lt/Th | | | | | | | | | 15 | C | 0.45 | 2 |
| Exit 3 Off Ramps SB LT | | | | | | | | | 18 | C | 0.64 | 5 |
| Exit 3 Off Ramps SB Th/Rt | | | | | | | | | 15 | B | 0.55 | 3 |
| Exit 3 Off Ramps SB Rt | | | | | | | | | 10 | B | 0.4 | 2 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | |
| Buzzards Bay (EB) Lt/Th | 25 | D | 0.66 | 5 | 25 | D | 0.66 | 5 | 288 (4.8) | **F** | 1.49 | 18 |
| Buzzards Bay (EB) Rt | 46 | **E** | 0.88 | 10 | 46 | **E** | 0.88 | 10 | 131 (2.2) | **F** | 1.16 | 17 |
| Roundabout Conn. (WB) Lt | 101 (1.7) | **F** | 1.16 | 31 | 101 (1.7) | **F** | 1.16 | 31 | | | | |
| Roundabout Conn. (WB) Th/Rt | 8 | A | 0.36 | 2 | 8 | A | 0.36 | 2 | | | | |
| Main Street (NB) Lt | 6 | A | 0.21 | 1 | 6 | A | 0.21 | 1 | | | | |
| Main Street (NB) Th/Rt | 272 (4.5) | **F** | 1.56 | 68 | 272 (4.5) | **F** | 1.56 | 68 | | | | |
| Main Street (NB) Lt/Th/Rt | | | | | | | | | 348 (5.8) | **F** | 1.70 | 45 |
| Scenic Highway (WB) Lt/Th | | | | | | | | | 110 (1.8) | **F** | 1.12 | 17 |
| Exit 3 Off Ramps SB LT | | | | | | | | | 88 (1.5) | **F** | 1.1 | 18 |
| Exit 3 Off Ramps SB Th/Rt | | | | | | | | | 204 (3.4) | **F** | 1.38 | 35 |
| Exit 3 Off Ramps SB Rt | | | | | | | | | 7 | A | 0.19 | 1 |

*Notes:*
*LOS E and LOS F movements are **bold***
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Shaded areas: Lane configuration does not exist during listed period.*

*Table 4-19 Belmont Circle - Comparison of Alternatives, Maximum Queue Length*

| APPROACHES | EXISTING (2014) | | FUTURE (2040) NO-BUILD | | ALTERNATIVE 1 (RECOMMENDED) | | ALTERNATIVE 1A | | ALTERNATIVE 2 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER |
| | (FEET/MILES) | | (FEET/MILES) | | (FEET/MILES) | | (FEET/MILES) | | (FEET/MILES) | |
| Route 25 Exit 3 Exit Ramp | 515 | 510 | 645 | **1,025** | 135 | 24 | 35 | 60 | 75 | 525 |
| Buzzards Bay Bypass WB | 100 | 335 | 110 | 305 | 261 | 36 | 261 | 636 | 225 | 270 |
| Main Street EB | 530 | **5,755 (1.1)** | 1,245 | **6,140 (1.2)** | 474 | 1,749 | 474 | 1,749 | 390 | 675 |
| Scenic Highway WB | 380 | **10,605 (2.0)** | 840 | **11,610 (2.2)** | 290 | 870 | 290 | 870 | 30 | 255 |

*Notes:*
*Queues over 2,500 feet also provided in miles.*
*Locations of excessive delay are **bold***

Under Alternative 1, maximum queue lengths during the non-summer weekday peak period for all approaches except the Buzzards Bay Bypass would be reduced to less than half of the future no-build condition. For example, the queuing at the Route 25 Exit 3 ramps approaching Belmont Circle would be reduced from 645 feet to 135 feet. However, the peak period maximum queue for the Buzzards Bay Bypass would increase from 110 feet to 261 feet. The reductions in maximum peak period queue length during the summer Saturday peak period is even more favorable with all approaches experiencing substantial reductions including the queuing on the Scenic Highway approach being reduced from 11,610 feet to 870 feet.

*Alternative 1A (Three-Leg Roundabout with Signalized Intersection and Flyover Ramp)*

The approaches to the roundabout would operate the same as Alternative 1 having the same result for LOS and delay for each roundabout approach. As in Alternative 1, the longest queues for Alternative 1B would be found on Main Street.

The new signalized intersection of Scenic Highway at the Route 25 exit ramp and the new roundabout connector road would operate at LOS B and LOS D during the non-summer weekday and summer Saturday peak periods, respectively. The signalized intersection is forecast to reduce the number and severity of crashes at this high crash location.

The results for the peak period maximum queue lengths under Alternative 1A would be very similar to Alternative 1 with the queues for all approaches except the Buzzards Bay Bypass being reduced to less than half of the future no-build condition. The reductions in the maximum length of peak period queues during the summer Saturday peak period would also be favorable with all approaches experiencing substantial reductions including a reduction in the Main Street queue from 6,140 feet to 1,749 feet.

*Alternative 2 (Four-Leg Roundabout)*

The approaches to Belmont Circle would operate within a range of LOS A to LOS F during the non-summer weekday peak period, with delays ranging from seven seconds at the Buzzards Bay Bypass to 3.1 minutes at Main Street approaches. However, during the summer Saturday peak period, all approaches would at LOS F with average delays ranging from 1.5 minutes (Exit 3 off ramps) to 5.8 minutes (Main Street).

Under Alternative 2, maximum queue lengths during the non-summer weekday peak period for all approaches except the Buzzards Bay Bypass would be reduced to less than half of the future no-build condition. For example, the queue at the Route 25 Exit 3 ramps approaching Belmont Circle would be reduced from 645 feet to 75 feet. However, the peak period maximum queue for the Buzzards Bay Bypass would increase from 110 feet to 225 feet. The reductions in maximum peak period queue length during summer Saturdays are even more favorable with all approaches experiencing substantial reductions including the queue on the Main Street approach being reduced from 11,610 feet to 255 feet.

### Environmental Resource Impact

As shown on Table 4-20, each of the three alternatives for the reconstruction of Belmont Circle would impact wetland resources and 100-year floodplain. Open space and residential and commercial property acquisitions may also be required.

*Table 4-20 Belmont Circle Reconstruction - Environmental Impact by Alternative*

| | SCENIC HWY TO ROUTE 25 WB RAMP | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 |
|---|---|---|---|---|
| RESOURCE AREAS (ACRES): | | | | |
| Rare Species Habitat | 0 | 0 | 0 | 0 |
| DEP Wetlands | 0 | 0.3 | 0.5 | 0.03 |
| 100-year Floodplain | 0 | 4.7 | 5.4 | 4.6 |
| Rare Species Habitat | 0 | 0 | 0 | 0 |
| IWPA (Interim Wellhead Protection Area) | 0.2 | 0.5 | 0.5 | 0.4 |
| RIGHT OF WAY (ACRES): | | | | |
| USACE | 0 | 0.1 | 0.1 | 0.1 |
| Residential | 0 | 0.02 | 0.02 | 0.02 |
| Commercial | 0 | 0.02 | 0.02 | 0.02 |
| Utility | 0.88 | 0 | 0 | 0 |

*Notes:*
*Environmental and right-of-way impact based on conceptual design and GIS-based data.*

## *Conceptual Cost Estimate*

The conceptual cost estimate for alternatives to reconstruct Belmont Circle are provided by construction year in Table 4-21. More detailed conceptual cost estimates are provided in Appendix E.

## *Suggested Alternative*

Alternative 1 – Three-Leg Roundabout with Signalized Intersection was advanced for further study during the travel model analysis (Exhibit 4-21). This alternative was selected because it would improve traffic operations with a simpler,

*Table 4-21 Belmont Circle Reconstruction – Conceptual Cost Estimate*

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Alternative 1 (recommended) | 14 | 23 | 33 |
| Alternative 1A | 24 | 41 | 60 |
| Alternative 2 | 13 | 21 | 26 |

*Note:*
*Cost estimates do not include construction cost for the Scenic Highway to Route 25 WB Ramp*

***Exhibit 4-21 Belmont Circle - Suggested Alternative***

less costly design (not having the bridge structure included in Alternative 1A).

Alternative 1 would substantially reduce queuing and vehicle delays compared to the future no-build condition. Environmental impacts were approximately the same for all alternatives.

### 4.6.5 Bourne Rotary

Several alternatives were evaluated to improve traffic operations at the Bourne Rotary. These alternatives were conceived to be compatible with the existing Bourne Bridge as well as with the vertical and horizontal alignment of an assumed replacement of the Bourne Bridge. The traffic analysis is based on location and geometry of the existing Bourne Bridge.

Each of these alternatives assumes that the local intersection improvements at the Sandwich Road at the Bourne Rotary Connector (described in Section 4.4.2) are completed. A larger-scale alternative to reconstruct Bourne Rotary as a highway interchange, likely in conjunction with the replacement of the Bourne Bridge, is described in Section 4.6.6.

All alternatives would include improvements to bicycle and pedestrian accommodations and maintain access to adjacent properties. Sidewalks, crosswalks, and bicycle lanes would be constructed on Old Sandwich Road to provide east-west access under the Bourne Bridge. These facilities would enhance access between public facilities such as the Upper Cape Cod Technical High School and the Bourne Middle School and High School. Pedestrian and bicycle access would also be improved between residential neighborhoods west of Route 28 and the Canal bike trail at the Bourne Recreational Area.

The development of alternatives is constrained by the existing environmental resources (Exhibit 2-16) and land uses at the Bourne Rotary (Exhibit 4-22) including the State Police Station and other commercial developments immediately adjacent to the Rotary. The existing and future traffic operations at Belmont Circle and Bourne Rotary are provided in Section 3.3.7.

As shown on Exhibit 4-23, three alternatives were advanced for analysis. A larger-scale improvement alternative for Bourne Rotary was also evaluated, as described in Section 4.6.6. The alternatives evaluated include:

*Alternative 1 - Route 28 Northbound Ramp*

Alternative 1 involves the construction of a ramp immediately east of the Rotary leading vehicles directly from Route 28 northbound to Sandwich Road, via the Bourne Rotary Connector.

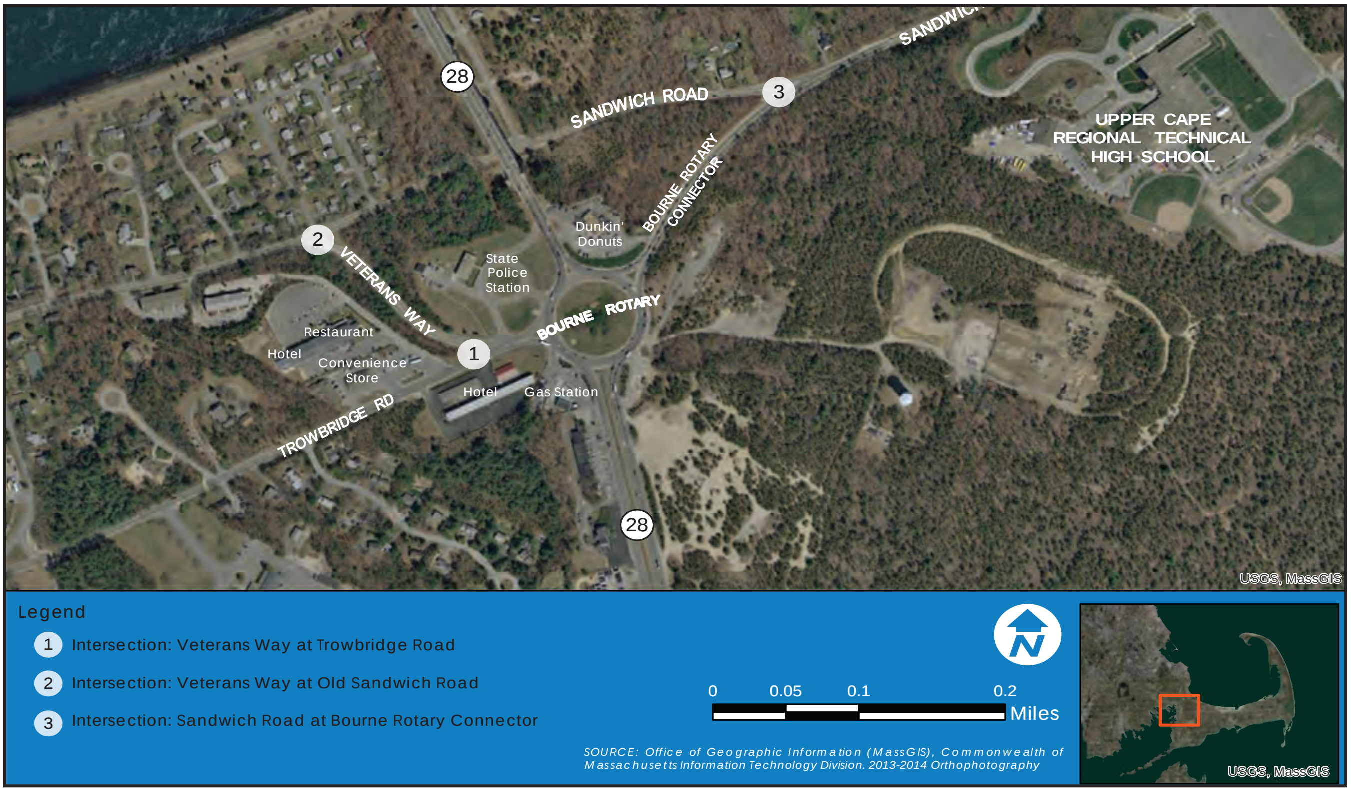
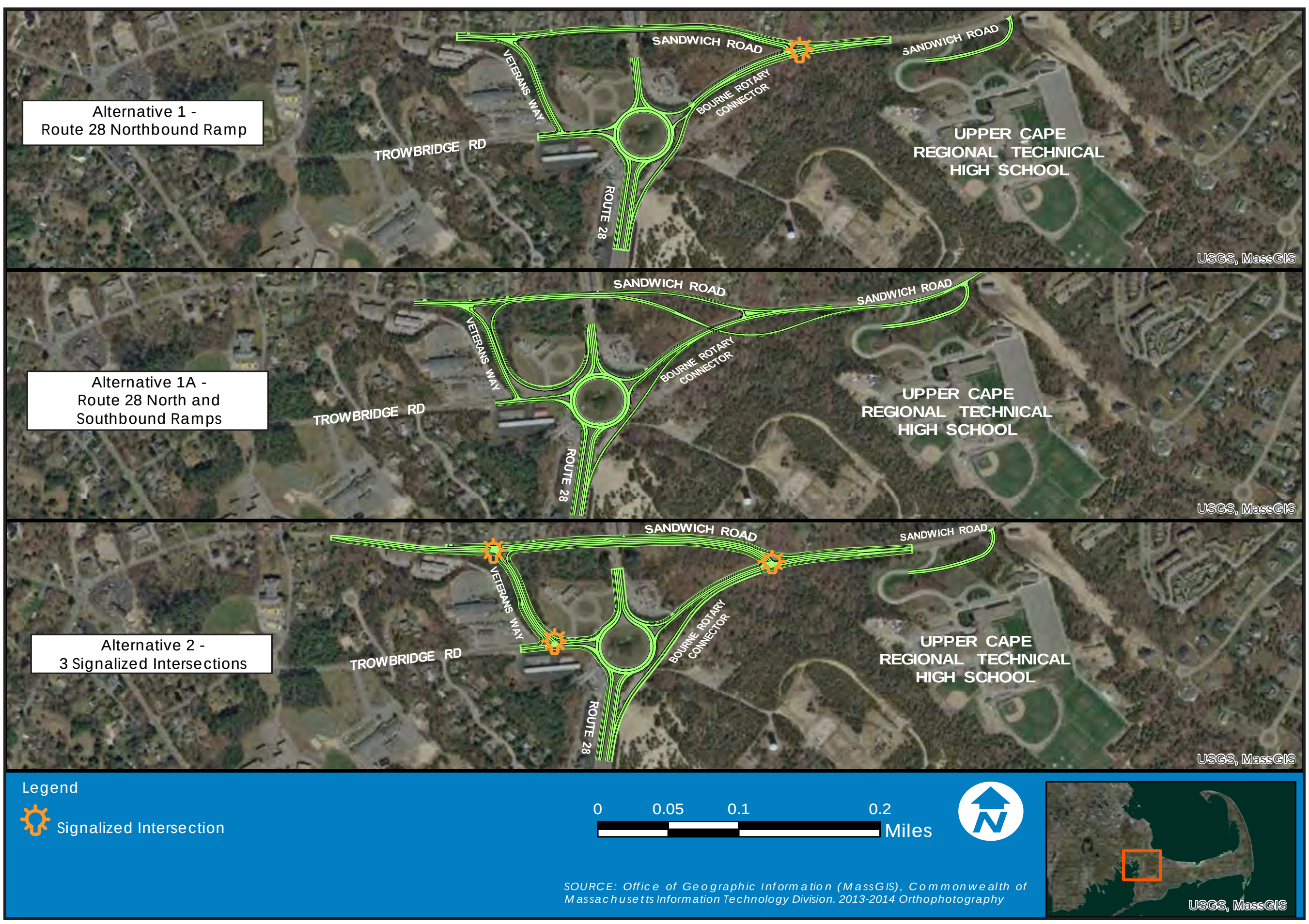



***Exhibit 4-22 Bourne Rotary - Existing Conditions***

***Exhibit 4-23 Alternatives Evaluated – Bourne Rotary***



This ramp would allow northbound vehicles on Route 28 direct access to Sandwich Road without having to enter the Rotary.

In addition to the reconstruction of the Sandwich Road at Bourne Rotary Connector intersection, this alternative includes the relocation of the Upper Cape Technical High School driveway approximately 300 feet to the east to provide some separation of the traffic entering and exiting the high school from the traffic entering Sandwich Road from the new Route 28 northbound ramp[1].

*Alternative 1A – Route 28 Northbound and Southbound Ramp with Sandwich Road Underpass*

Alternative 1A builds upon the Route 28 northbound ramp to Sandwich Road (proposed under Alternative 1) in proposing a second ramp leading from Route 28 southbound looping around State Police property at Veterans Way and continuing north to Sandwich Road. These ramps would allow northbound and southbound vehicles on Route 28 direct access to Sandwich Road without having to enter the Rotary.

This alternative also includes the relocation and conversion of an approximately 0.3 mile section of the Sandwich Road eastbound lanes into an underpass at the Bourne Rotary Connector intersection. The relocated section of Sandwich Road eastbound would begin immediately east of the Bourne Bridge underpass and re-connect with the existing Sandwich Road alignment approximately 300 feet east of the Bourne Rotary Connector. This new eastbound alignment of Sandwich Road, with the Bourne Rotary Connector underpass, would allow eastbound vehicles a direct path to Sandwich Road without having to enter the Bourne Rotary.

This alternative also includes the relocation of the Technical High School driveway approximately 300 feet to the east to provide some separation of the traffic entering and exiting the high school from the traffic entering Sandwich Road from the new Route 28 northbound ramp.

1 The relocation of the high school driveway is a conceptual element of the reconstruction of Bourne Rotary. When the project advances into the implementation phase, MassDOT will hold coordination meetings with the Upper Cape Cod Technical High School

*Alternative 2 – Three Signalized Intersections*

Alternative 2 involves the reconstruction and signalization of three intersections in the immediate Bourne Rotary area at the following locations:

- Intersection 1: Veterans Way at Trowbridge Road
- Intersection 2: Veterans Way at Old Sandwich Road
- Intersection 3: Sandwich Road at Bourne Rotary Connector

In addition to construction of these three signalized intersections, Alternative 2 includes the construction of a ramp providing a direct connection from Route 28 northbound to Sandwich Road, via the Bourne Rotary Connector, as in Alternatives 1and 1A. A second ramp leading from Route 28 southbound, looping around the State Police property at Veterans Way and continuing north to Sandwich Road is also incorporated, as well as the relocation of the Technical High School driveway approximately 300 feet to the east.

Unique to Alternative 2 is the reconstruction of the Rotary such that travel across the north side of the Rotary would not be allowed. Vehicles entering the Rotary from Trowbridge Road or Route 28 northbound would only be allowed to exit at the Bourne Rotary Connector (to Sandwich Road) or continue to Route 28 northbound across the Bourne Bridge. This disconnection would reduce traffic volumes in the Rotary and allow for freer movement from Route 28 southbound into the Rotary. East-west travel in this area would be accomplished using Sandwich Road.

### Traffic Analysis

A traffic analysis was completed of the three alternatives developed for the Bourne Rotary. Traffic operations at the three intersections adjacent to the Rotary (listed above for Alternative 2) were compared to identify a preferred alternative. The results of this analysis are summarized below and shown on Table 4-22 through Table 4-24. A comparison of the maximum peak period queue lengths for the approaches to Belmont Circle for the existing condition, future no-build condition, and the three alternatives are provided in Table 4-25.

*Alternative 1 - Route 28 Northbound Ramp*

1. Veterans Way at Trowbridge Road: This intersection would remain unsignalized with the approaches operating within the range of LOS A – C. At 22 and 20 seconds, the Veterans Way approach would have the longest delay during the non-summer weekday and summer Saturday peak periods, respectively.

*Text continues on page 4-58.*

Table 4-22 Bourne Rotary, Traffic Operations - Comparison of Alternatives, Veterans Way at Trowbridge Road

| | ALTERNATIVE 1 | | | | ALTERNATIVE 1A | | | | ALTERNATIVE 2 (RECOMMENDED) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FUTURE (2040) BUILD CONDITIONS - SCREENING ANALYSIS | | | | | | | | | | | | |
| | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **95% QUEUE** *Feet (Miles)* | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **95% QUEUE** *Feet (Miles)* | **AVERAGE DELAY** *Sec (Min)* | **LOS** | **V/C** | **50% QUEUE** *Feet (Miles)* | **95% QUEUE** *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | |
| Trowbridge Road EB Th | 0.5 | A | 0.02 | 2 | 0.5 | A | 0.02 | 2 | | | | | |
| Trowbridge Road WB Th/Rt | 0 | A | 0.26 | 0 | 0 | A | 0.26 | 0 | | | | | |
| Veterans Way NB Lt/Rt | 22 | C | 0.29 | 29 | 22 | C | 0.29 | 29 | | | | | |
| Trowbridge Rd EB Lt/Th | | | | | | | | | 19 | B | 0.81 | 136 | 241 |
| Trowbridge Rd WB Th | | | | | | | | | 10 | B | 0.34 | 44 | 80 |
| Trowbridge Rd WB Rt | | | | | | | | | 12 | B | 0.56 | 0 | 49 |
| Veteran's Way SB Lt | | | | | | | | | 16 | B | 0.62 | 102 | 221 |
| Veteran's Way SB Rt | | | | | | | | | 10 | A | 0.1 | 0 | 29 |
| **Intersection (Overall)** | | | | | | | | | **14.3** | **B** | **0.72** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | |
| Trowbridge Road EB Th | 0.3 | A | 0.01 | 1 | 0.3 | A | 0.01 | 1 | | | | | |
| Trowbridge Road WB Th/Rt | 0 | A | 0.24 | 0 | 0 | A | 0.24 | 0 | | | | | |
| Veterans Way NB Lt/Rt | 20 | C | 0.18 | 17 | 20 | C | 0.18 | 17 | | | | | |
| Trowbridge Rd EB Lt/Th | | | | | | | | | 42 | D | 0.93 | 262 | 458 |
| Trowbridge Rd WB Th | | | | | | | | | 17 | B | 0.27 | 56 | 100 |
| Trowbridge Rd WB Rt | | | | | | | | | 21 | C | 0.62 | 0 | 96 |
| Veteran's Way SB Lt | | | | | | | | | 29 | C | 0.88 | 311 | 549 |
| Veteran's Way SB Rt | | | | | | | | | 10 | A | 0.14 | 0 | 31 |
| **Intersection (Overall)** | | | | | | | | | **26.9** | **C** | **0.9** | | |

*Notes:*
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Shaded areas: Lane configuration does not exist during listed period.*

Table 4-23 Bourne Rotary, Traffic Operations - Comparison of Alternatives, Veterans Way at Old Sandwich Road

| | ALTERNATIVE | | | | ALTERNATIVE 1A | | | | ALTERNATIVE 2 (RECOMMENDED) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FUTURE (2040) BUILD CONDITIONS - SCREENING ANALYSIS | | | | | | | | | | | | |
| | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | 95% QUEUE Feet (Miles) |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | |
| Old Sandwich Road EB Th/Rt | 0 | A | 0.24 | 0 | 0 | A | 0.25 | 0 | 25 | C | 0.6 | 75 | 111 |
| Old Sandwich Road WB Th/Lt | 3 | A | 0.05 | 4 | 2 | A | 0.02 | 2 | | | | | |
| Veterans Way NB Lt/Rt | 13 | B | 0.1 | 8 | 13 | B | 0.09 | 8 | | | | | |
| Old Sandwich Road WB Th | | | | | | | | | 28 | C | 0.9 | 138 | 317 |
| Old Sandwich Road WB Rt | | | | | | | | | 8 | A | 0.13 | 24 | 46 |
| Veterans Way NB Lt | | | | | | | | | 16 | B | 0.19 | 30 | 65 |
| Veterans Way NB Rt | | | | | | | | | 28 | C | 0.72 | 46 | 281 |
| **Intersection (Overall)** | | | | | | | | | **25.4** | **C** | **0.88** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | |
| Old Sandwich Road EB Th/Rt | 0 | A | 0.13 | 0 | 0 | A | 0.14 | 0 | 49 | D | 0.6 | 80 | 120 |
| Old Sandwich Road WB Th/Lt | 1 | A | 0.02 | 2 | 0.5 | A | 0.01 | 1 | | | | | |
| Veterans Way NB Lt/Rt | 10 | B | 0.05 | 4 | 11 | B | 0.06 | 5 | | | | | |
| Old Sandwich Road WB Th | | | | | | | | | 25 | C | 0.89 | 424 | 897 |
| Old Sandwich Road WB Rt | | | | | | | | | 5 | A | 0.13 | 29 | 71 |
| Veterans Way NB Lt | | | | | | | | | 37 | D | 0.14 | 29 | 57 |
| Veterans Way NB Rt | | | | | | | | | 53 | D | 0.69 | 23 | 274 |
| **Intersection (Overall)** | | | | | | | | | **37.1** | **D** | **0.88** | | |

*Notes:*
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Shaded areas: Lane configuration does not exist during listed period.*

Table 4-24 Bourne Rotary, Traffic Operations - Comparison of Alternatives, Sandwich Road at Bourne Rotary Connector

| | ALTERNATIVE | | | | | ALTERNATIVE 1A | | | | ALTERNATIVE 2 (RECOMMENDED) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FUTURE (2040) BUILD CONDITIONS - SCREENING ANALYSIS | | | | | | | | | | | | | |
| | AVERAGE DELAY Sec (Min) | LOS | V/C | 50% QUEUE Feet (Miles) | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | AVERAGE DELAY Sec (Min) | LOS | V/C | 95% QUEUE Feet (Miles) | 95% QUEUE Feet (Miles) |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | | |
| Bourne Rotary Connector EB Lt | 0 | A | 0 | 0 | 0 | | | | | 13 | B | 0.37 | 17 | 37 |
| Bourne Rotary Connector EB Th | 1 | A | 0.59 | 0 | 0 | | | | | 11 | B | 0.49 | 118 | 190 |
| Sandwich Road WB Th | 17 | B | 0.79 | 205 | 436 | | | | | 31 | C | 0.88 | 236 | 422 |
| Sandwich Road WB Rt | 98 (1.6) | A | 0.29 | 0 | 41 | | | | | 15 | B | 0.38 | 0 | 58 |
| Old Sandwich Road EB Lt | 22 | C | 0.54 | 69 | 127 | | | | | 28 | C | 0.86 | 194 | 297 |
| Old Sandwich Road EB Rt | 14 | B | 0.47 | 63 | 131 | 51 | F | 0.73 | 126 | | | | | |
| Old Sandwich Road EB Lt/Rt | | | | | | | | | | 16 | B | 0.12 | 0 | 38 |
| Bourne Rotary Conn. EB Lt/Th | | | | | | 0.5 | A | 0.02 | 1 | | | | | |
| Sandwich Rd WB Th/Rt | | | | | | 0 | A | 0.71 | 0 | | | | | |
| **Intersection (Overall)** | **9.7** | **A** | **0.78** | | | | | | | **21.9** | **C** | **0.85** | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | | |
| Bourne Rotary Connector EB Lt | 33 | C | 0.13 | 10 | 32 | | | | | 38 | D | 0.87 | 50 | 172 |
| Bourne Rotary Connector EB Th | 2 | A | 0.69 | 0 | 0 | | | | | 15 | B | 0.76 | 237 | 384 |
| Sandwich Road WB Th | 24 | C | 0.9 | 396 | 715 | | | | | 37 | D | 0.92 | 262 | 467 |
| Sandwich Road WB Rt | 7 | A | 0.12 | 0 | 25 | | | | | 18 | B | 0.58 | 2 | 82 |
| Old Sandwich Road EB Lt | 36 | D | 0.7 | 108 | 192 | | | | | 34 | C | 0.9 | 195 | 303 |
| Old Sandwich Road EB Rt | 19 | B | 0.15 | 14 | 52 | 110 (1.8) | F | 0.91 | 158 | | | | | |
| Old Sandwich Road SB Lt/Rt | | | | | | | | | | 17 | B | 0.09 | 0 | 35 |
| Bourne Rotary Conn EB Lt/ Th | | | | | | 1 | A | 0.03 | 3 | | | | | |
| Sandwich Rd WB Th/Rt | | | | | | 0 | A | 0.92 | 0 | | | | | |
| **Intersection (Overall)** | **13.9** | **B** | **0.89** | | | | | | | **26** | **C** | **0.93** | | |

*Notes:*
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles*
*Shaded areas: Lane configuration does not exist during listed period.*

2. Veterans Way at Old Sandwich Road: This intersection would remain unsignalized with the approaches operating within the range of LOS A – B. At 13 and 10 seconds, the Veterans Way approach would have the longest delay during the non-summer weekday and summer Saturday peak periods, respectively.

3. Sandwich Road at Bourne Rotary Connector: Under Alternative 1, this intersection would be signalized with dedicated turning lanes provided at the Old Sandwich Road eastbound and Bourne Rotary Connector eastbound approaches. This intersection would operate at an overall LOS A during the non-summer weekday and LOS B during the summer Saturday peak periods.

Under Alternative 1, maximum queue lengths would vary for the four approaches to the Bourne Rotary when compared to the future no-build condition during the non-summer weekday peak period (Table 4-25). While the queues for Route 28 northbound and Bourne Rotary Connector approaches would experience modest or no improvement, the peak period queues on the Route 28 southbound and Trowbridge Road approaches would increase. The queue at the Route 28 southbound approach would increase from 620 feet to 9,320 feet and the Trowbridge Road queue would increase from 3,465 feet to 4,895 feet. The results for the summer Saturday peak period are similar except for Trowbridge Road would experience a modest increase in queuing and the Route 28 southbound approach queue would increase from 1.9 miles to 5.2 miles.

*Table 4-25 Bourne Rotary - Comparison of Alternatives, Maximum Queues Length*

| APPROACHES | EXISTING (2014) | | FUTURE (2040) NO-BUILD | | ALTERNATIVE 1 | | ALTERNATIVE 1A | | ALTERNATIVE 2 (RECOMMENDED) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER | NON-SUMMER | SUMMER |
| | *Feet (Miles)* | | *Feet (Miles)* | | *Feet (Miles)* | | *Feet (Miles)* | | *Feet (Miles)* | |
| Route 28 SB | 650 | **8,885 (1.7)** | 620 | **9,935 (1.9)** | **9,340 (1.8)** | **27,564 (5.2)** | **2,955 (1.8)** | **17,029 (3.2)** | **5,620 (1.1)** | **13,685 (2.6)** |
| Trowbridge Road EB | 840 | 335 | **3,465 (0.7)** | **2,225** | **4,895 (0.9)** | **3,052 (0.6)** | **1,760** | **1,684** | **7,445 (1.4)** | **7,443 (1.4)** |
| Route 28 NB | 340 | 4,130 (0.8) | 1,275 | **3,605 (0.7)** | 635 | 309 | 175 | 214 | 210 | 371 |
| Bourne Rotary | 1,530 | 1,475 | 855 | **6,430 (1.2)** | 875 | 877 | 875 | 874 | 50 | 50 |

*Notes:*
*Lt = Left Rt = Right Th = Through; EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service; V/C = Volume to Capacity Ratio*
*Overall LOS, V/C and queues not calculated for unsignalized intersections.*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Excessive delays **bold***

*Alternative 1A - Route 28 Northbound and Southbound Ramp*

1. Veterans Way at Trowbridge Road: This intersection would remain unsignalized with the approaches operating within the range of LOS A – C. At 22 and 20 seconds, the Veterans Way approach would have the longest delay during the non-summer weekday and summer Saturday peak periods, respectively.

2. Veterans Way at Old Sandwich Road: This intersection would remain unsignalized with the approaches operating within the range of LOS A – B. At 13 and 11 seconds, the Veterans Way approach would have the longest delay during the non-summer weekday and summer Saturday peak periods, respectively.

3. Sandwich Road at Bourne Rotary Connector: This intersection would remain unsignalized under Alternative 1A. Similar to the existing condition, vehicles would have difficulty entering Sandwich Road from Old Sandwich Road, with that minor approach operating at LOS F during both the non-summer weekday and summer Saturday peak periods.

Under Alternative 1A, maximum queue lengths would vary for the four approaches to the Bourne Rotary when compared to the future no-build condition during the non-summer weekday peak period. Similar to Alternative 1, the queues for Route 28 northbound and Bourne Rotary Connector approaches would experience modest or no improvement. However, the peak period queues on the Route 28 southbound and Trowbridge Road approaches would increase. The queue at the Route 28 southbound approach would increase from 620 feet to 2,955 feet and the Trowbridge Road queue would increase from 3,465 feet to 4,895 feet. The results for the summer Saturday peak period are similar except for Trowbridge Road would experience a modest reduction in queue length. During the summer Saturday peak period the Route 28 southbound queue would increase from 1.9 miles to 3.2 miles.

*Alternative 2 - Three Signalized Intersections*

1. Veterans Way at Trowbridge Road: Under Alternative 2, this intersection would be signalized with dedicated turn lanes at the Trowbridge Road westbound and Veterans Way southbound approaches. The intersection would have an overall LOS of B in the non-summer weekday and LOS C during the summer Saturday peak periods. Average delay for the intersection would be approximately 14 seconds (non summer weekday) and 27 seconds (summer Saturday).

2. Veterans Way at Old Sandwich Road: Under Alternative 2, this intersection would be signalized with dedicated turn lanes at the Old Sandwich Road westbound and Veterans Way northbound approaches. The intersection would have an overall LOS of C during the non-summer weekday and LOS D during the summer Saturday peak periods. Average delay for the intersection during peak periods would be approximately 25 seconds (non summer weekday) and 37 (summer Saturday).

3. Sandwich Road at Bourne Rotary Connector: Under Alternative 2, this intersection would be signalized with dedicated turn lanes at the Bourne Rotary Connector eastbound and Old Sandwich Road southbound approaches. The intersection would have an overall LOS of C during the non-summer weekday and summer Saturday peak periods. Average delay for the intersection during peak periods would be approximately 25 seconds (non-summer weekday) and 37 seconds (summer Saturday).

Under Alternative 2, maximum queue lengths would vary for the four approaches to the Bourne Rotary when compared to the future no-build condition during the non-summer weekday peak period. The queue for Route 28 northbound approach would be substantially reduced from 1,275 feet to 210 feet and the queue at the Bourne Rotary Connector reduced from 855 feet to 50 feet. However, the peak period queues would persist on the Route 28 southbound and Trowbridge Road approaches with non-summer weekday queues at 5,620 feet and 7,445 feet, respectively.

The results for the summer Saturday peak period are similar to the non-summer weekday period with only minor queues at the Route 28 northbound and Bourne Rotary Connector approaches but persistent, longer queues at the Route 28 southbound and Trowbridge Road approaches. However, the queue on Route 28 southbound is substantially shorter when compared to Alternatives 1 and 1A.

### *Environmental Resource and Property Impacts*

As shown on Table 4-26, none of the three alternatives evaluated for the reconstruction of the Bourne Rotary would impact wetland resources, 100-year floodplain, or rare species habitat. Alternative 1A would require the acquisition of approximately one acre of land from the Town of Bourne. All alternatives may require minor property acquisitions from the USACE and adjacent residential and commercial properties.

This Route 28 ramp may require a minor property acquisition from the Massachusetts State Police barracks.

Table 4-26 Bourne Rotary - Environmental Impact by Alternative

| | ALTERNATIVE 1 | ALTERNATIVE 1A | ALTERNATIVE 2 |
|---|---|---|---|
| RESOURCE AREAS (ACRES): | | | |
| DEP Wetlands | 0 | 0 | 0 |
| 100-year Floodplain | 0 | 0 | 0 |
| Rare Species Habitat | 0 | 0 | 0 |
| RIGHT OF WAY (ACRES): | | | |
| Town of Bourne | 0 | 1.0 | 0 |
| USACE | 0.1 | 0.2 | 0.4 |
| Residential | 0.02 | 0.02 | 0.3 |
| Commercial | 0 | 0.2 | 0.01 |

*Notes:*
*Environmental and right-of-way impact based on conceptual design and GIS-based data.*

Table 4-27 Bourne Rotary Reconstruction – Conceptual Cost Estimates

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Alternative 1 | 8 | 13 | 19 |
| Alternative 1A | 16 | 27 | 39 |
| Alternative 2 (recommended) | 11 | 18 | 26 |

### *Conceptual Cost Estimate*

The conceptual costs for alternatives to reconstruct Bourne Rotary are provided by construction year in Table 4-27. More detailed conceptual cost estimates are provided in Appendix E.

### *Suggested Alternative*

Alternative 2 – Three Signalized Intersection – was advanced for further study during the travel model analysis (Exhibit 4-24). This alternative was selected because it would result in acceptable traffic operations at all three adjacent intersections. The Veterans Way at Trowbridge Road intersection would operate LOS B and C for the non-summer weekday and summer Saturday peak periods, respectively. The Veterans Way at Old Sandwich Road intersection would operate at LOS C and D and the Sandwich Road at Bourne Rotary Connector intersection would operate at LOS C for both time periods.

Based on the conceptual design, this alternative could be incorporated into the Bourne Rotary Interchange alternative and, ultimately, a replacement Bourne Bridge. This alternative would have less property impact to the Massachusetts State Police barracks.


**Exhibit 4-24** ***Bourne Rotary - Suggested Alternative***

## 4.6.4 Bourne Rotary Interchange

A larger-scale alternative to improve traffic operations at the Bourne Rotary was evaluated. This alternative involves the reconstruction of the Bourne Rotary as a highway interchange. This alternative assumes the prior intersection improvements at Bourne Rotary (Alternative 2 – Three Signalized Intersections) are already in place.

This alternative was conceived to be constructed concurrent with an assumed replacement of the Bourne Bridge, with an alignment immediately east of the existing bridge. The existing and future traffic operations at the Bourne Rotary are described in Sections 2.5.10 and 3.3.7, respectively. The existing land uses and environmental resources in the Bourne Rotary area are described in Section 2.2.2.

### *Suggested Improvements*

The reconstruction of the Bourne Rotary as a highway interchange intersection involves the removal of the Rotary and the construction of a grade-separated highway ramp system allowing vehicles to enter Route 28 (northbound or southbound)


***Exhibit 4-25 Bourne Rotary Interchange***

directly from Sandwich Road (via the Bourne Rotary Connector) or Trowbridge Road (Exhibit 4-25). Local traffic would pass directly over Route 28 on an overpass. The grade-separated interchange would remove the numerous conflict points that currently exist at the Rotary, substantially reducing queuing and crash rates.

### *Traffic Conditions*

The reconstruction of the Bourne Rotary as a highway interchange would substantially reduce peak period queuing on the Rotary approach roadways including Route 28 (northbound and southbound), Trowbridge Road, and the Bourne Rotary Connector (Table 4-28). Currently, the Bourne Rotary suffers from LOS F conditions during all peak periods. Construction of a highway interchange would improve traffic operations, forecast to range from LOS A to LOS C conditions.

### *Property or Environmental Resource Impact*

As shown on Table 4-29, the Bourne Rotary Interchange alternative would not impact wetland resources, 100-year

*Table 4-28 Traffic Operations - Bourne Rotary Interchange*

| | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 3A | | |
|---|---|---|---|
| | DELAY *Sec* | LOS | 95% QUEUE *Feet/Direction* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | |
| Trowbridge Rd & Veteran's Way | 9 | A | 73/SB |
| Bourne Rotary Connector & Old Sandwich Road | 11 | B | 200/EB |
| Veteran's Way & Old Sandwich Road | 21 | C | 348/EB |
| Exit 4 SB On Ramp/Trowbridge Road & Sandwich Rd Connector | 1 | -- | 4/WB |
| Exit 4 NB Off Ramp & Sandwich Rd Connector | 9 | -- | 42/NB |
| Trowbridge Road & Exit 4 SB Off Ramp | 1 | -- | 12/SB |
| **Intersection (Overall)** | **8.9** | **A** | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | |
| Trowbridge Rd & Veteran's Way | 10 | A | 107/SB |
| Bourne Rotary Connector & Old Sandwich Road | 13 | B | 257/EB |
| Veteran's Way & Old Sandwich Road | 28 | C | 452/WB |
| Exit 4 SB On Ramp/Trowbridge Road & Sandwich Rd Connector | 0.4 | -- | 2/WB |
| Exit 4 NB Off Ramp & Sandwich Rd Connector | 13 | -- | 99/NB |
| Trowbridge Road & Exit 4 SB Off Ramp | 2 | -- | 28/SB |
| **Intersection (Overall)** | **11.0** | **B** | |

*Notes:*
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*

*Table 4-29 Bourne Rotary Interchange - Potential Property or Environmental Impact*

| | ALTERNATIVE 1 |
|---|---|
| ENVIRONMENTAL RESOURCES | |
| DEP Wetlands | 0 |
| 100-year Floodplain | 0 |
| Rare Species Habitat | 0.2 |
| PROPERTY IMPACT | |
| Town of Bourne | 0 |
| USACE | 0.4 |
| Residential | 0.3 |
| Commercial | 2.2 |

floodplains or land owned by the Town of Bourne. This alternative may impact a minor amount of rare species habitat (0.2 acres). The interchange alternative would require the acquisition of approximately 0.4 acres of land from the USACE and 0.3 acres of residential property. The interchange would also require approximately 2.2 acres of commercial land east of the Rotary.

### *Conceptual Cost Estimate*

The conceptual cost for the Bourne Rotary Interchange is provided by construction year in Table 4-30. More detailed conceptual cost estimates are provided in Appendix E.

*Table 4-30 Bourne Rotary Interchange – Conceptual Cost Estimate by Build Year*

| | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|
| Bourne Rotary Interchange[1] | 69 | 101 |

*Note:*
*[1] Includes cost of Bourne Rotary - Three Signalized Intersections Improvements.*

# 4.7 BOURNE AND SAGAMORE BRIDGE REPLACEMENT OR REHABILITATION

The Bourne and Sagamore Bridges play an integral part of the transportation network in the study area. However, they are both owned by the USACE, not the Commonwealth of Massachusetts, and decisions regarding their future rehabilitation or replacement will be made by the USACE. The following section provides information regarding the existing bridge features and the potential features of replacement bridge structures based on current highway design standards, characteristics of the adjacent highway network, and future traffic volumes. Multimodal transportation facilities have also been considered for the potential future bridge design.

## 4.7.1 Bourne and Sagamore Bridges – Potential Replacement Design Features

The Sagamore and Bourne Bridges both opened in 1935 and are nearing the end of their usable service lives. The bridges have been designated as eligible for individual listing on the National Register of Historic Places by the Massachusetts Historic Commission.

As noted in chapter 1, the U.S. Army Corps of Engineers (USACE) owns and maintains these bridges. The USACE is currently conducting a study of both bridges called a Major Rehabilitation Evaluation Report. The outcome of this study will be a

determination of whether to continue long-term maintenance of the bridges or to replace them. This determination may be different for each bridge.

For this planning study, it is assumed that the USACE will determine that both Bridges require complete replacement. However, most study alternatives were developed to be compatible with the existing or replacement bridges.

Identical in design, each highway bridge is approximately 48-feet in width, providing four 10-foot-wide traffic lanes (two lanes in each direction), with no roadway shoulder or median. A single six-foot-wide sidewalk and a two-foot safety walk are provided along opposite sides of the Bridges.

The sidewalks are on the east side of the Sagamore Bridge and the west side of the Bourne Bridge. The design of the bridges is substandard for lane widths, lack of roadway shoulders and medians, and having no ADA compliant bicycle and pedestrian accommodation. At a six-percent grade, the vertical profile of the bridges is steeper than the four- to five-percent maximum grade typical for a limited-access highway.

Additional substandard design features at the highway approaches to the bridges contribute to peak period congestion. Approaching the Sagamore Bridge from the north, one of the two travel lanes in Route 3 southbound is dropped to allow travelers from Scenic Highway to merge onto Route 3 at Exit 1A, reinstating the second travel lane. This substandard roadway geometry contributes to congestion and delays on Route 3 southbound, especially during peak periods.

Immediately south of the Bourne Bridge, the unsignalized Bourne Rotary constrains Route 25 eastbound traffic flows over the bridge. During peak periods, queues extend from all rotary approaches, particularly on Route 28 northbound and Route 25 eastbound. The queue on Route 25 often extends several thousand feet over the Bourne Bridge, to the point where vehicles are constrained from entering Route 25 from Belmont Circle.

Based on the local topography, existing land uses, and environmental resources, it is assumed that these replacement bridges would be constructed immediately adjacent to and inside of the existing Bridges. A replacement Bourne Bridge would be built to the east of the existing bridge and a replacement Sagamore Bridge would be built to the west of the existing bridge (Exhibit 4-26).

It is also assumed that replacement Canal Bridges would be multimodal structures designed to current MassDOT highway design standards and policies. Specifically, a bridge with a much

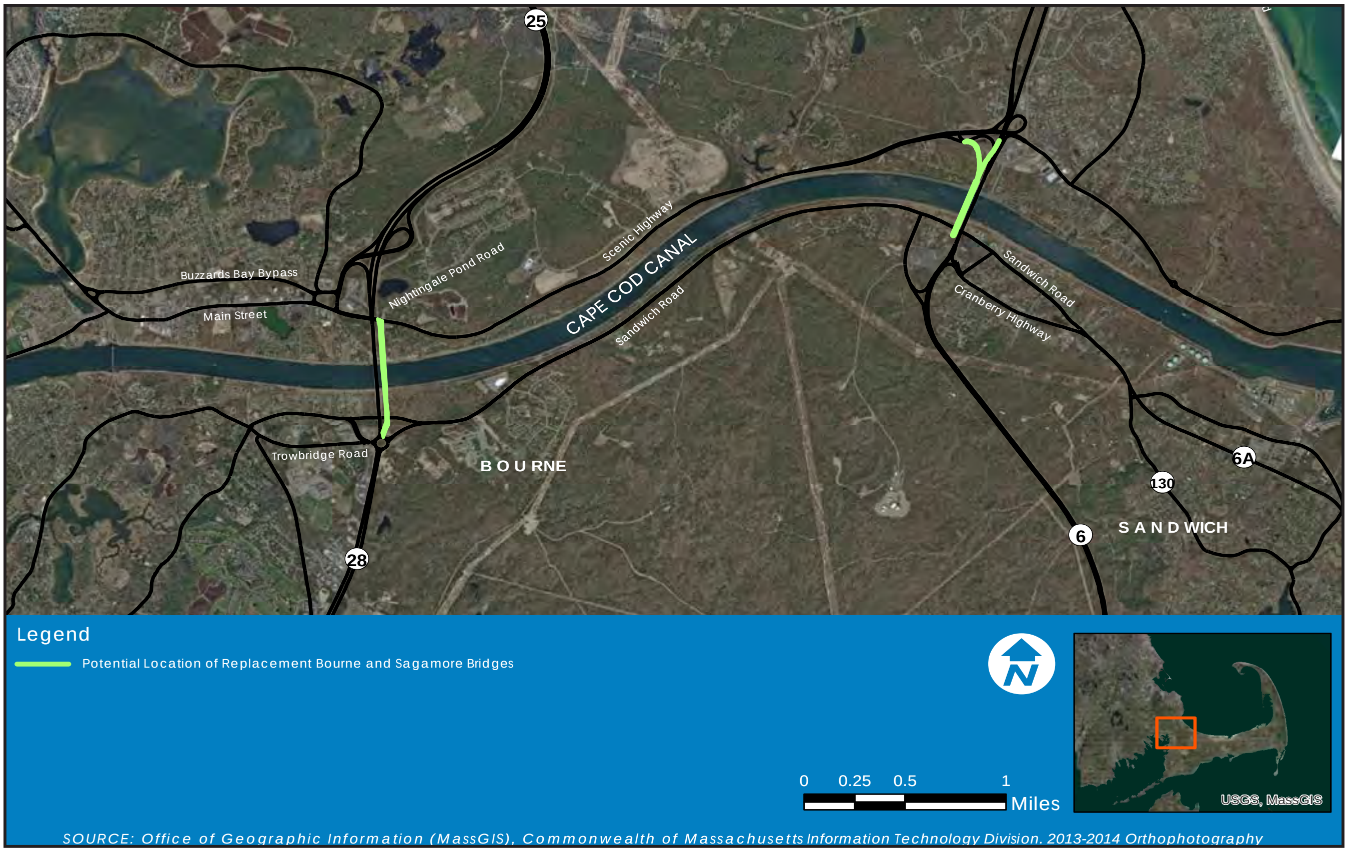
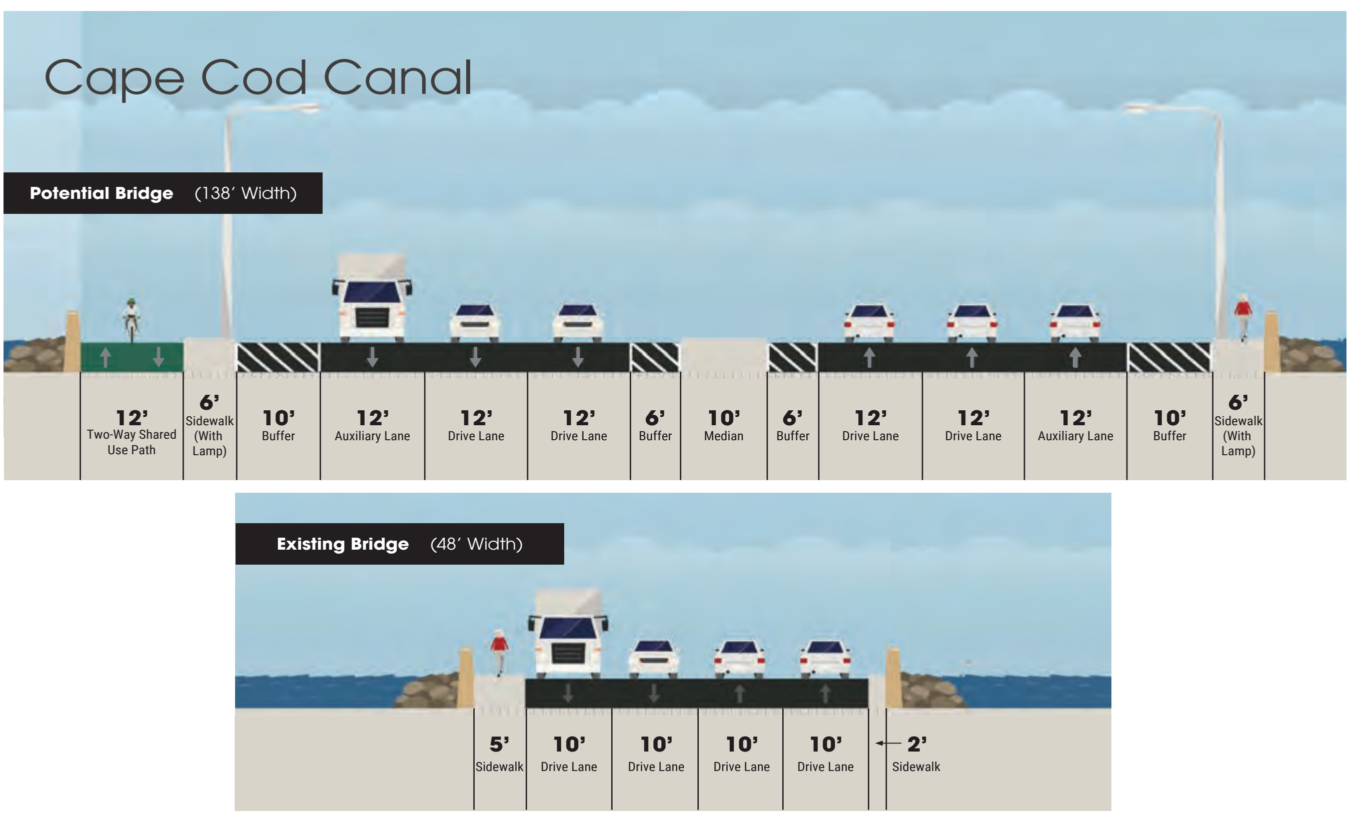



***Exhibit 4-26 Potential Alignment - Bourne and Sagamore Bridge Replacement***

***Exhibit 4-27 Potential Cross Section - Bourne and Sagamore Bridge Replacements***



wider cross section is envisioned to accommodate all users. This cross section could be up to 138 feet wide, including two 12-foot lanes in each direction and a single12-foot auxiliary traffic lane in each direction. These lanes would be separated by a 10-foot wide median. Bicyclists and pedestrians could cross the bridge on a 12-foot wide shared-use path on one side of the bridge with a 6.0-foot wide pedestrian sidewalk on the other side of the bridge (Exhibit 4-27).

The addition of auxiliary lanes on the replacement bridges would provide appropriate acceleration and deceleration lanes for vehicles entering or exiting at the gateway intersections in the Canal area and eliminate the need for the lane drop present at the Route 3 southbound approach to the Sagamore Bridge. By separating the vehicles entering and exiting the highway from through traffic, the auxiliary lanes would reduce turbulence in the roadway system, alleviating the traffic bottleneck common at the Canal bridges.

These auxiliary lanes are intended to reduce congestion and improve safety in the immediate area of the bridges but not result in a significant increase in the capacity of the overall Canal-area roadway system.

## 4.8 REGIONAL TRANSPORTATION ANALYSIS MODELING

The following sections describe the analysis conducted using the regional travel demand model to identify the most effective combination of transportation improvements in the study area.

As noted in Section 3.3.1, future no-build traffic conditions in the study area were forecast using a regional travel demand model (based on existing travel volumes and forecast socio-economic conditions in the study area). The maximum queuing and average delays for the future no-build, non-summer weekday and summer Saturday at Belmont Circle and Bourne Rotary are presented on Exhibit 3-18. Building on that data, the travel demand model was also used to test the effectiveness of transportation improvements in the study area.

The travel demand model provides a method for combining groups of transportation improvements (known as ‘cases’) to evaluate their effectiveness. Based on the 2040 traffic volumes presented in Chapter 3, the travel demand model also estimates potential shifts or diversions in travel patterns in the study area that may cause unforeseen traffic congestion in other locations. For example, improved roadway and bridge infrastructure may result in travelers diverting trips across the Canal from one bridge rather than the other.

This exercise enabled the understanding of the level of transportation improvements necessary to provide acceptable traffic operations in the study area for the 2040 non summer weekday PM period without overbuilding in a manner inconsistent with the character of Cape Cod.

The initial alternative screening analysis (described in Sections 4.5) was based on future no-build traffic volumes at specific locations. The travel demand model simulates traffic movements throughout the study area, assuming existing traffic patterns continue in the future. The model produces future traffic volumes at numerous locations throughout the study area for various daily time periods and time of year. Using these traffic volumes, further analysis is conducted using traffic analysis software including VISSIM™ and Synchro™ (as described in Section 2.5.5). As the travel demand model re assigns travel routes based on travel times, the volume of vehicles traveling through intersections in the study area often changes compared to the volumes used during the screening analysis, resulting in somewhat different results.

Seven cases were selected for analysis to provide logical and comprehensive groups of improvements. These seven cases, presented in the following sections, generally build upon one another with the first cases incorporating smaller intersection improvements and subsequent cases including an increasing number of transportation improvements. The nine different potential components of the travel demand model cases are listed on Table 4-31 and shown on Exhibit 4-28.

*Table 4-31 Components of the Seven Travel Analysis Cases*

| MAP LOCATION | IMPROVEMENTS | CASE 1 | CASE 1A | CASE 1B | CASE 2 | CASE 2B | CASE 3 | CASE 3A |
|---|---|---|---|---|---|---|---|---|
| A | Scenic Highway to Route 25 Westbound On-Ramp | ✱ | ✱ | ✱ | ✱ | ✱ | ✱ | ✱ |
| B | Route 6 Exit 1C Relocation | ✱ | | | ✱ | ✱ | ✱ | ✱ |
| C | Route 28 Northbound Ramp to Sandwich Road | | ✱ | ✱ | ✱ | ✱ | ✱ | |
| D | Bourne Rotary (3 New Signalized Intersections) | | | ✱ | ✱ | ✱ | ✱ | |
| E | Belmont Circle (3-Leg Roundabout plus Signalized Intersection) | | | | ✱ | | ✱ | ✱ |
| F | Belmont Circle with Route 25 Eastbound Flyover | | | | | ✱ | | |
| G | Replacement Canal Bridges (Bourne and Sagamore) | | | | | | ✱ | ✱ |
| H | Route 6 Eastbound Travel Lane from Exit 1A to Exit 2 | | | | | | ✱ | ✱ |
| I | Bourne Rotary with Highway Interchange | | | | | | | ✱ |

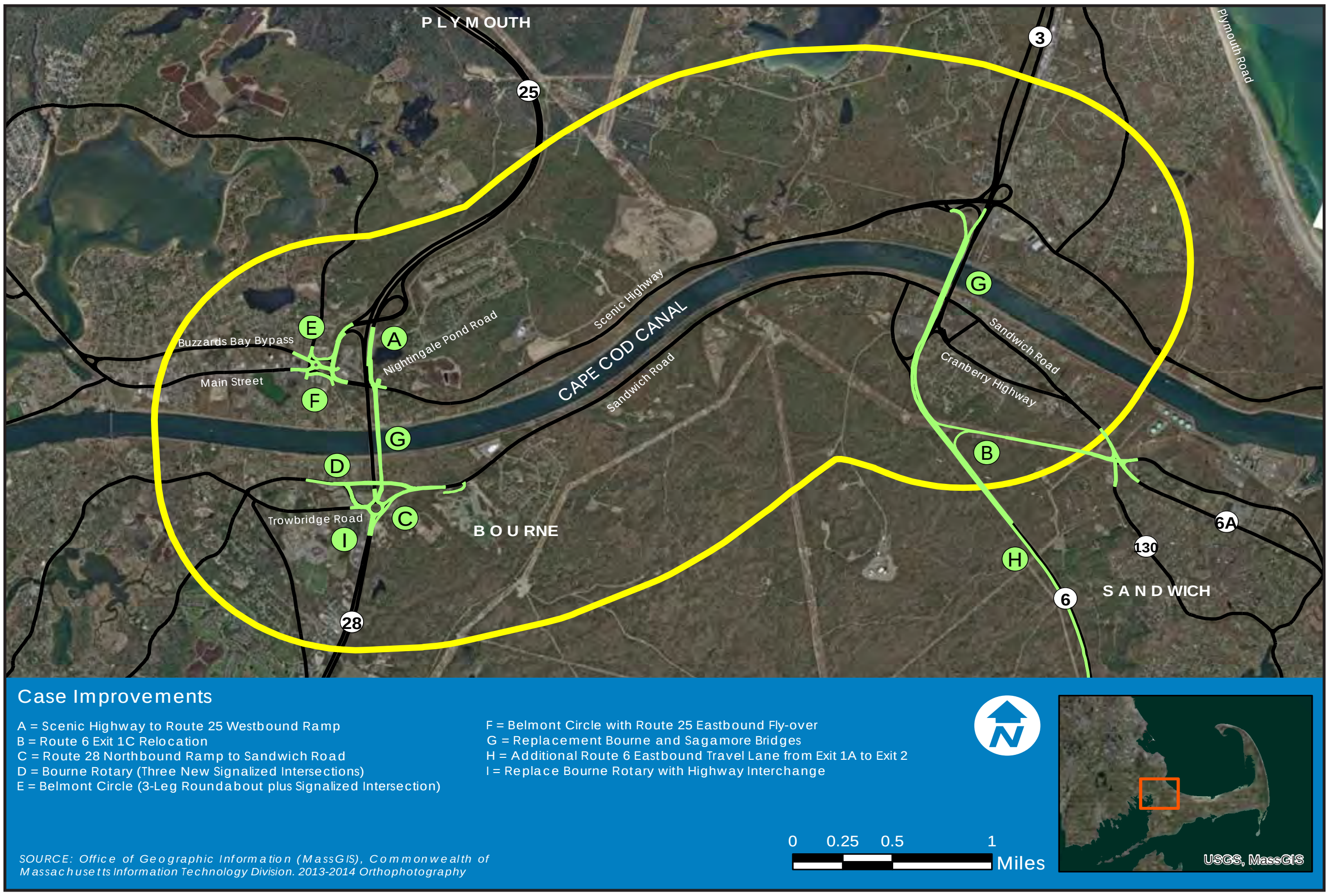
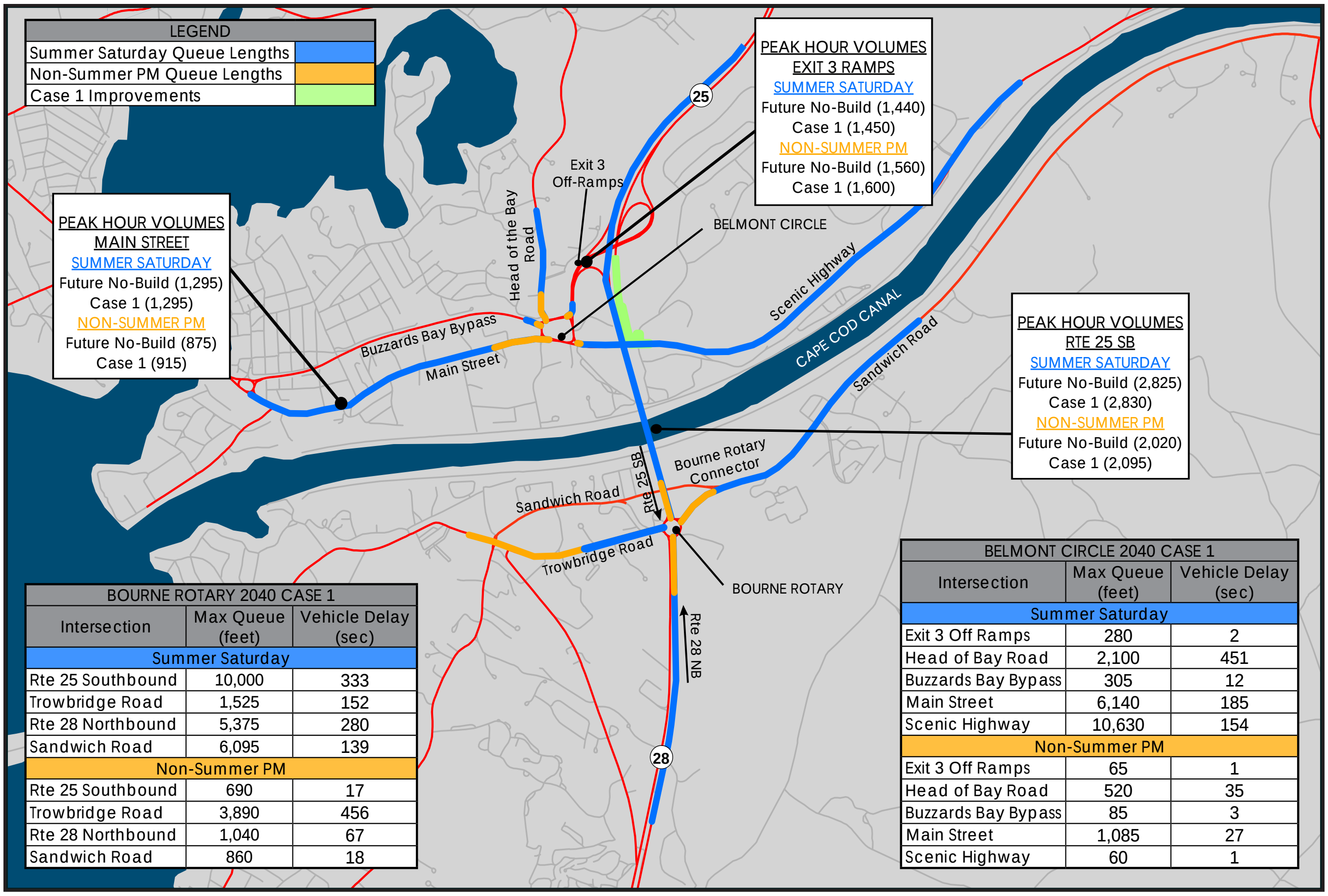



***Exhibit 4-28 Location of Components of Travel Demand Model Cases***

Cases 1, 1A, 1B, 2, and 2B were analyzed with the existing Canal bridges remaining in place as the improvements proposed under these cases could proceed as stand-alone projects without requiring any future action by the USACE. However, if the USACE proceeds with the replacement of the Canal bridges, these improvements, with modest modifications, would be compatible with the assumed location and layout of these replacement bridges. Cases 3 and 3A assume that replacement Canal bridges are in place.

The effectiveness of the following cases was determined by how they perform during the non-summer weekday PM (4:00 – 6:00 PM) and summer Saturday (10:00 AM – 12:00 PM) peak periods, when compared to the future no-build conditions at Belmont Circle and Bourne Rotary in terms of vehicle queuing, delays, and level of service.

Traffic conditions were also analyzed for the Route 3 southbound and Route 6 westbound approaches to the Sagamore Bridge (Exhibit 4-29). The results of this analysis are described in the following sections for Cases 1, 3, and 3A. A description of the results for Cases 1A and 1B are not provided as they effectively




| BOURNE ROTARY 2040 CASE 1 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 10,000 | 333 |
| Trowbridge Road | 1,525 | 152 |
| Rte 28 Northbound | 5,375 | 280 |
| Sandwich Road | 6,095 | 139 |
| Non-Summer PM | | |
| Rte 25 Southbound | 690 | 17 |
| Trowbridge Road | 3,890 | 456 |
| Rte 28 Northbound | 1,040 | 67 |
| Sandwich Road | 860 | 18 |

| BELMONT CIRCLE 2040 CASE 1 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 280 | 2 |
| Head of Bay Road | 2,100 | 451 |
| Buzzards Bay Bypass | 305 | 12 |
| Main Street | 6,140 | 185 |
| Scenic Highway | 10,630 | 154 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 65 | 1 |
| Head of Bay Road | 520 | 35 |
| Buzzards Bay Bypass | 85 | 3 |
| Main Street | 1,085 | 27 |
| Scenic Highway | 60 | 1 |

***Exhibit 4-29 Case 1- Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***

unchanged from the future no-build condition because these cases do not include improvements in the Sagamore Bridge area (such as the relocation of Route 6 Exit 1C or the addition of a travel lane of Route 6 eastbound). The results for Cases 2 and 2B are effectively the same as Case 1.

## 4.9 TRAVEL DEMAND MODEL – CASE ANALYSIS

The following sections describe the seven travel demand model cases evaluated and the findings of this analysis.

### 4.9.1 Case 1

Case 1 includes the evaluation of the following transportation improvements:

- Scenic Highway to Route 25 Westbound Entrance Ramp
- Route 6 – Relocation of Exit 1C

These two improvements were selected to be evaluated together as Case 1 because they are modestly-priced improvements that would improve peak period traffic operations in two of the most

congested intersections in the study area, Belmont Circle and Bourne Rotary. They could both be built entirely within MassDOT right-of-way.

More detailed information is provided below on the forecast traffic operations under Case 1 at Belmont Circle and Bourne Rotary (also see Table 4-32 and Exhibit 4-29), and the Route 3 and Route 6 approaches to the Sagamore Bridge (Table 4-33 and Exhibit 4-30).

### *Belmont Circle*

**Result:** Overall, Implementation of Case 1 would result in a modest improvement to traffic operations in Belmont Circle with more substantial improvement forecast during the non-summer weekday than the summer Saturday peak period.

**Cause:** The construction of a new Route 25 westbound entrance ramp (described in Section 4.6.4) would divert 1,340 of 1,705 vehicles during the non-summer weekday peak period that currently travel west on Scenic Highway and enter Belmont Circle to the new ramp. With fewer vehicles entering the Circle from Scenic Highway westbound, there would be a notable reduction in queuing at certain approaches to Belmont Circle, including the Route 25 Exit 3 ramp and Head of the Bay Road during both the non-summer weekday PM and summer Saturday peak periods. However, other approaches to Belmont Circle, including Scenic Highway, Buzzards Bay Bypass, and Main Street would not see a reduction in queuing and delays.

### *Bourne Rotary*

**Result:** Traffic operations at the Bourne Rotary would not improve under Case 1 either in the non-summer weekday or summer Saturday peak periods. As shown in Table 4-32, some approaches would experience a reduction in queuing and related delays, while others may experience an increase in queuing and delays. Bourne Rotary would experience little improvement in traffic operations.

**Cause:** Roadway design at Bourne Rotary remains unchanged and there is no change in traffic volumes entering the Rotary.

### *Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

**Result:** With the relocation of Route 6 Exit 1C, implementation of Case 1 would also affect traffic operations on the Route 3/Route 6 corridor. Queuing and delays are forecast to be substantially reduced for vehicles heading off-Cape on Route 6 westbound. Compared to the future no-build condition, during the summer

*Table 4-32 Case 1 - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary*

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 65 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 35 | D | 520 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 85 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 27 | D | 1,085 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 1 | A | 60 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **13.4** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 2 | A | 280 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 451 (7.52) | **F** | 2,100 |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 12 | B | 305 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 185 (3.08) | **F** | 6,140 (1.16) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 154 (2.57) | **F** | 10,630 (2.01) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **160.8 (2.68)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 17 | C | 65 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 456 (7.6) | **F** | 520 |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 67 (1.12) | **F** | 85 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 18 | C | 1,085 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **139.5 (2.33)** | **F** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 333 (5.55) | **F** | 10,000 (1.89) |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 152 (2.53) | **F** | 1,525 |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 280 (4.67) | **F** | 5,375 (1.02) |
| Sandwich Rd WB | 27 | D | 1475 | 135 (2.25) | **F** | 6,430 (1.22) | 139 (2.32) | **F** | 6,095 (1.15) |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **226 (3.77)** | **F** | |

*Notes:*
*LOS E and LOS F movements are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

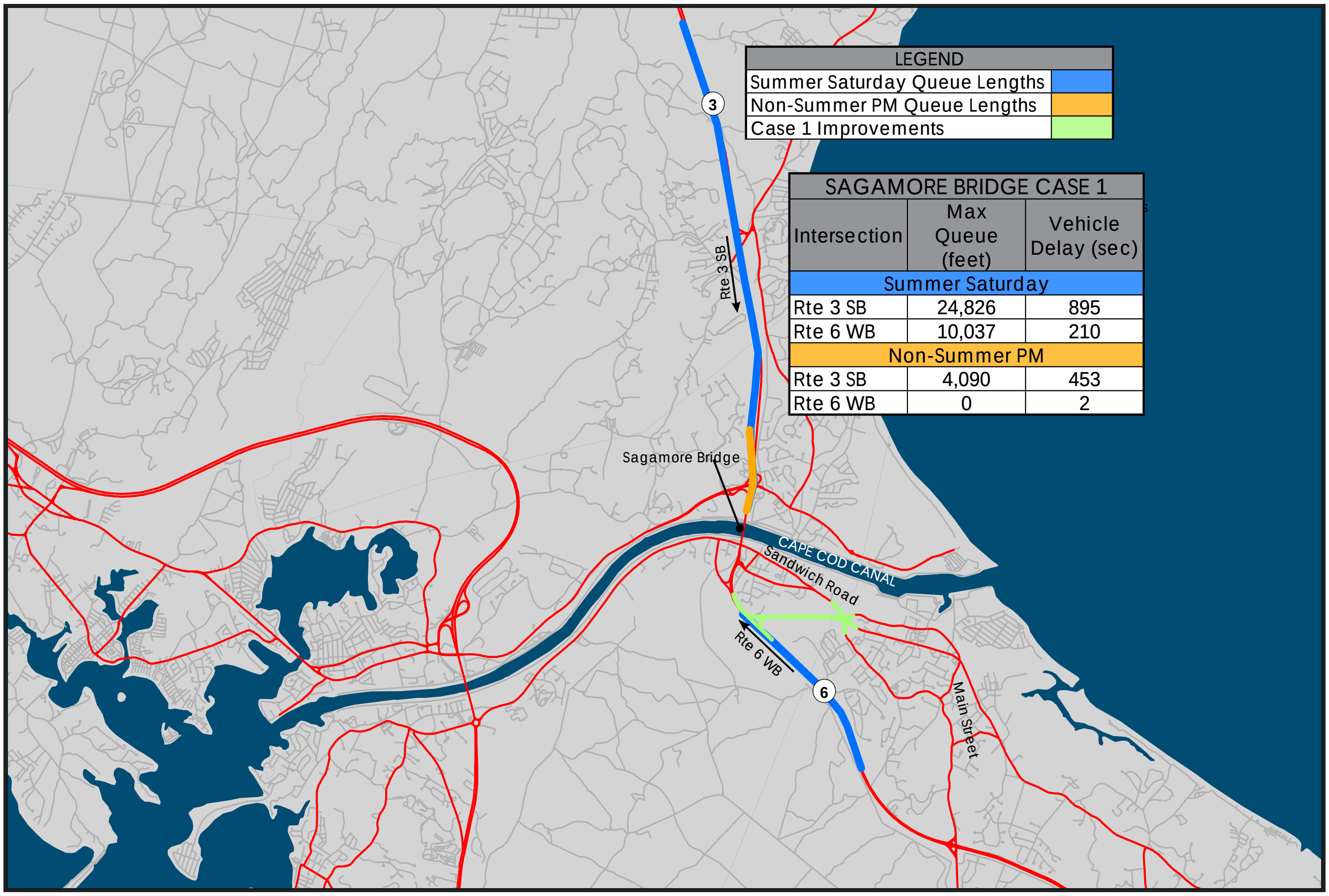



***Exhibit 4-30 Case 1 - Maximum Queues and Average Delay, Sagamore Bridge Approaches***

*Table 4-33 Case 1 Traffic Operations, Sagamore Bridge Approaches*

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | |
| Route 3 Southbound | 11 | B | 77 | 478 | 460 (7.7) | F | 7,481 (1.4) | 8,476 (1.6) | 453 (7.5) | F | 3,534 (0.7) | 4,090 (0.8) |
| Route 6 Westbound | 5 | A | 53 | 232 | 178 (3.0) | F | 6,801 (1.3) | 7,967 (1.5) | 2 | A | 0 | 0 |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | |
| Route 3 Southbound | 416 (6.9) | F | 4,823 (0.91) | 5,393 (1.02) | 887 (14.8) | F | 22,814 (4.3) | 24,484 (4.6) | 895 (14.9) | F | 23,308 (4.4) | 24,826 (4.7) |
| Route 6 Westbound | 683 (11.4) | F | 23,318 (4.4) | 25,014 (4.7) | 812 (13.5) | F | 24,825 (4.7) | 25,029 (4.7) | 210 (3.5) | F | 7,253 (1.4) | 10,037 (1.9) |

*Notes:*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

Saturday peak period, the maximum queue length is forecast to decline from approximately 4.7 miles to 1.9 miles (Table 4-33). Average delay during this same peak period would decrease from 13.5 minutes to 3.5 minutes. During the non-summer weekday period, in 2040 queuing and delays on Route 6 westbound would be eliminated, improving traffic conditions from LOS F to LOS A.

However, traffic queuing and delays on Route 3 southbound is not forecast to change compared to the future no-build condition because no roadway improvements are proposed that would change traffic conditions on Route 3 southbound. The result of the traffic analysis at the proposed roundabout at the Route 6 Exit 1C ramp at Route 6A and Route 130 is provided in Table 4-12 in Section 4.6.1.

**Cause:** The longer acceleration and deceleration lanes associated with the relocated Exit 1C and the greater distance from the Sagamore Bridge approach both contribute to reduced turbulence along Route 6 westbound.

### 4.9.2 Case 1A

Case 1A includes the following transportation improvements:

- Scenic Highway to Route 25 Westbound Entrance Ramp
- Route 28 Northbound Ramp to Sandwich Road (at Bourne Rotary)

Case 1A represents two transportation improvements with modest cost and limited environmental permitting requirements based on conceptual design completed for this study. This case assumes that the improvement at the intersection of Sandwich Road at Bourne Rotary Connector (including the relocation of the Technical High School driveway) has been implemented. More detailed information on the forecast traffic operations under Case 1A at Belmont Circle and Bourne Rotary is provided below (also see Table 4-34 and Exhibit 4-31).

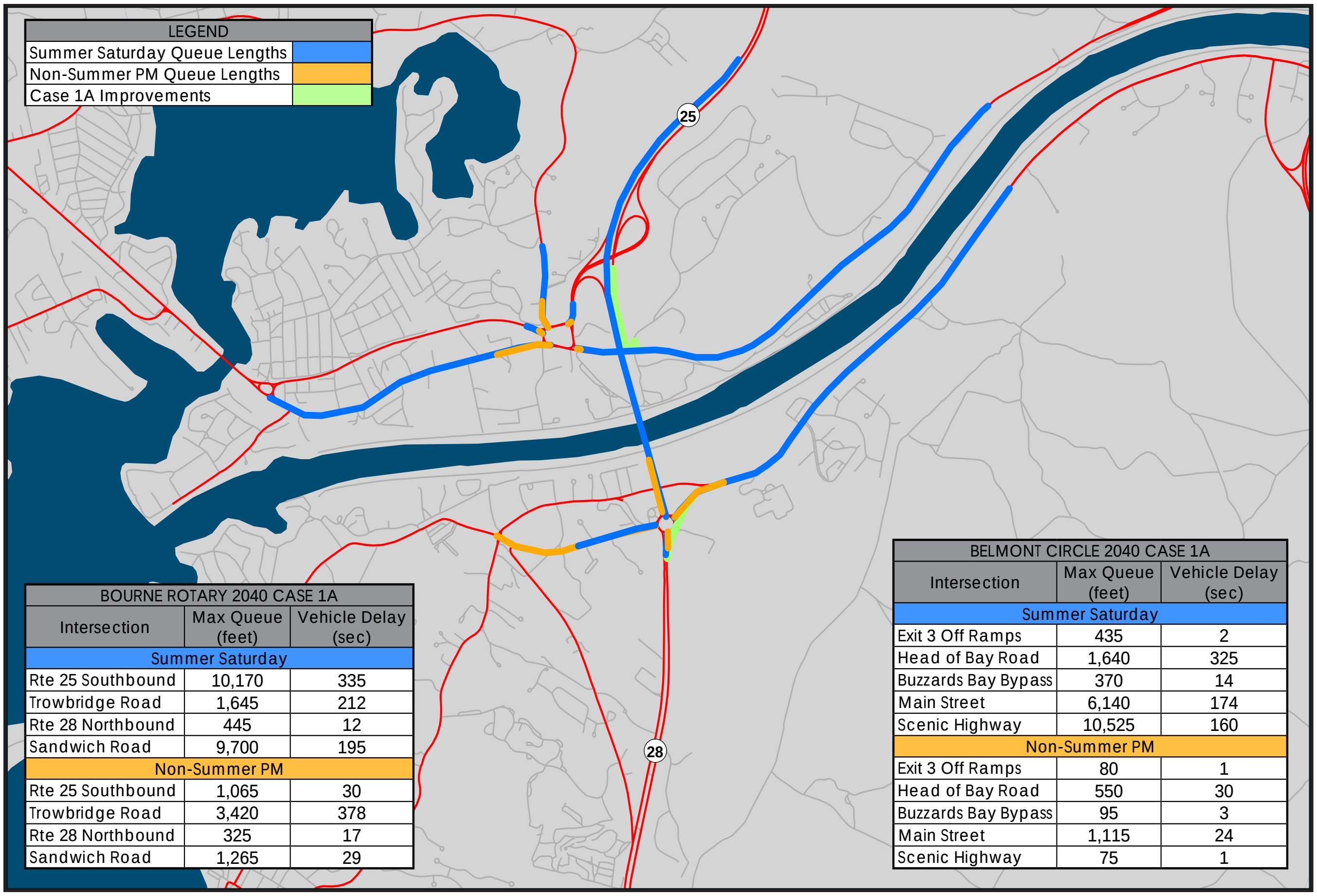
#### *Belmont Circle*

**Result:** Overall, the implementation of the Case 1A improvements would result in a moderate improvement in traffic operations at Belmont Circle with more substantial improvement forecast during the non-summer weekday than the summer Saturday peak period when comparing the future no-build condition to the build condition. Greater reductions in queues are forecast at the Route 25 off-ramps and Head of the Bay Road approach to the Circle but little improvement at the other approaches to the Circle, including Scenic Highway, Buzzards Bay Bypass, and Main Street.

Table 4-34 Case 1A - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1A | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 80 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 30 | D | 550 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 95 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 24 | C | 1,115 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 1 | A | 75 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **11.8** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 2 | A | 435 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 337 (5.62) | F | 1,640 |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 14 | B | 370 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 172 (2.87) | F | 6,140 (1.16) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 154 (2.57) | F | 10,525 (1.99) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **135.8 (2.26)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 30 | D | 1,065 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 378 (6.3) | F | 3,420 (0.65) |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 17 | C | 325 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 29 | D | 1,265 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **113.5 (1.89)** | **F** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 337 (5.62) | F | 10,170 (1.93) |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 213 (3.55) | F | 1,645 |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 13 | B | 445 |
| Sandwich Rd WB | 27 | D | 1,475 | 135 (2.25) | **F** | 6,430 (1.22) | 198 (3.3) | F | 9,700 (1.84) |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **190.25 (3.17)** | **F** | |

*Notes:*
*LOS E and LOS F locations are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*




| BOURNE ROTARY 2040 CASE 1A | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 10,170 | 335 |
| Trowbridge Road | 1,645 | 212 |
| Rte 28 Northbound | 445 | 12 |
| Sandwich Road | 9,700 | 195 |
| Non-Summer PM | | |
| Rte 25 Southbound | 1,065 | 30 |
| Trowbridge Road | 3,420 | 378 |
| Rte 28 Northbound | 325 | 17 |
| Sandwich Road | 1,265 | 29 |

| BELMONT CIRCLE 2040 CASE 1A | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 435 | 2 |
| Head of Bay Road | 1,640 | 325 |
| Buzzards Bay Bypass | 370 | 14 |
| Main Street | 6,140 | 174 |
| Scenic Highway | 10,525 | 160 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 80 | 1 |
| Head of Bay Road | 550 | 30 |
| Buzzards Bay Bypass | 95 | 3 |
| Main Street | 1,115 | 24 |
| Scenic Highway | 75 | 1 |

***Exhibit 4-31 Case 1A - Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***

**Cause:** The construction of a new Route 25 westbound entrance ramp would divert 1,310 of 1,735 vehicles during the non-summer weekday peak period to the ramp that currently travel west on Scenic Highway and enter Belmont Circle. With fewer vehicles entering the Circle from Scenic Highway westbound, there would be a notable reduction in queuing at certain approaches to Belmont Circle, including the Route 25 Exit 3 off-ramp and Head of the Bay Road during both the non-summer weekday and summer Saturday peak periods. However, other approaches to Belmont Circle, including Scenic Highway, Buzzards Bay Bypass, and Main Street would not see a reduction in queues and delay substantial traffic volumes would continue to enter the Circle from those approaches.

### *Bourne Rotary*

**Result:** Overall, traffic operations at the Bourne Rotary would improve moderately under Case 1A compared to the future no-build condition. Route 28 northbound is the only approach that is forecast to experience a substantial reduction in delay, especially during the summer Saturday peak period. Delay at all other approaches would remain approximately the same as the

future no-build condition during both the non-summer weekday and summer Saturday peak periods.

**Cause:** The new Route 28 northbound ramp to Sandwich Road reduces delay on the Route 28 northbound approach to the Bourne Rotary. During the summer Saturday peak period, maximum queues are forecast to drop from over 3,600 feet to 445 feet, with a corresponding reduction in average delay from 3.1 minutes to 13 seconds. The results for the other approaches during the summer Saturday peak period would be mixed, with some delays increasing and others decreasing. Compared to the future no-build condition, the maximum queue on the Sandwich Road westbound approach to the Bourne Rotary would increase from 6,430 feet to 9,700 feet while the Trowbridge Road approach would decrease from 2,225 feet to 1,645 feet.

*Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

As shown on Exhibit 4-39, under Case 1A travel conditions on the approaches to the Sagamore Bridge would be effectively unchanged for the future no-build condition during both the non-summer weekday PM and summer Saturday peak periods. Because these cases do not include improvements in the Sagamore Bridge area (including the relocation of Route 6 Exit 1C or the addition of a travel lane of Route 6 eastbound).

### 4.9.3 Case 1B

Case 1B includes the following transportation improvements:

- Scenic Highway to Route 25 Westbound Ramp
- Route 28 Northbound Ramp to Sandwich Road (at Bourne Rotary)
- Bourne Rotary Reconstruction (Alternative 2 – Three Signalized Intersections)

Case 1B includes a highway entrance ramp from Scenic Highway westbound to Route 25 westbound, a ramp from Route 28 northbound to Sandwich Road, and the full reconstruction of the Bourne Rotary, including three new signalized intersections in the immediate are of the Rotary. This case represents a potential interim condition if the Bourne Rotary reconstruction were to be completed prior to the Belmont Circle reconstruction.

The reconstruction of Bourne Rotary prior to Belmont Circle would be desirable because of the proximity of Belmont Circle and Bourne Rotary to one another. Improvements to Bourne Rotary – particularly at the Route 25 southbound approach – are required for improvements at Belmont Circle to be effective because of queuing on the Route 25 southbound approach to

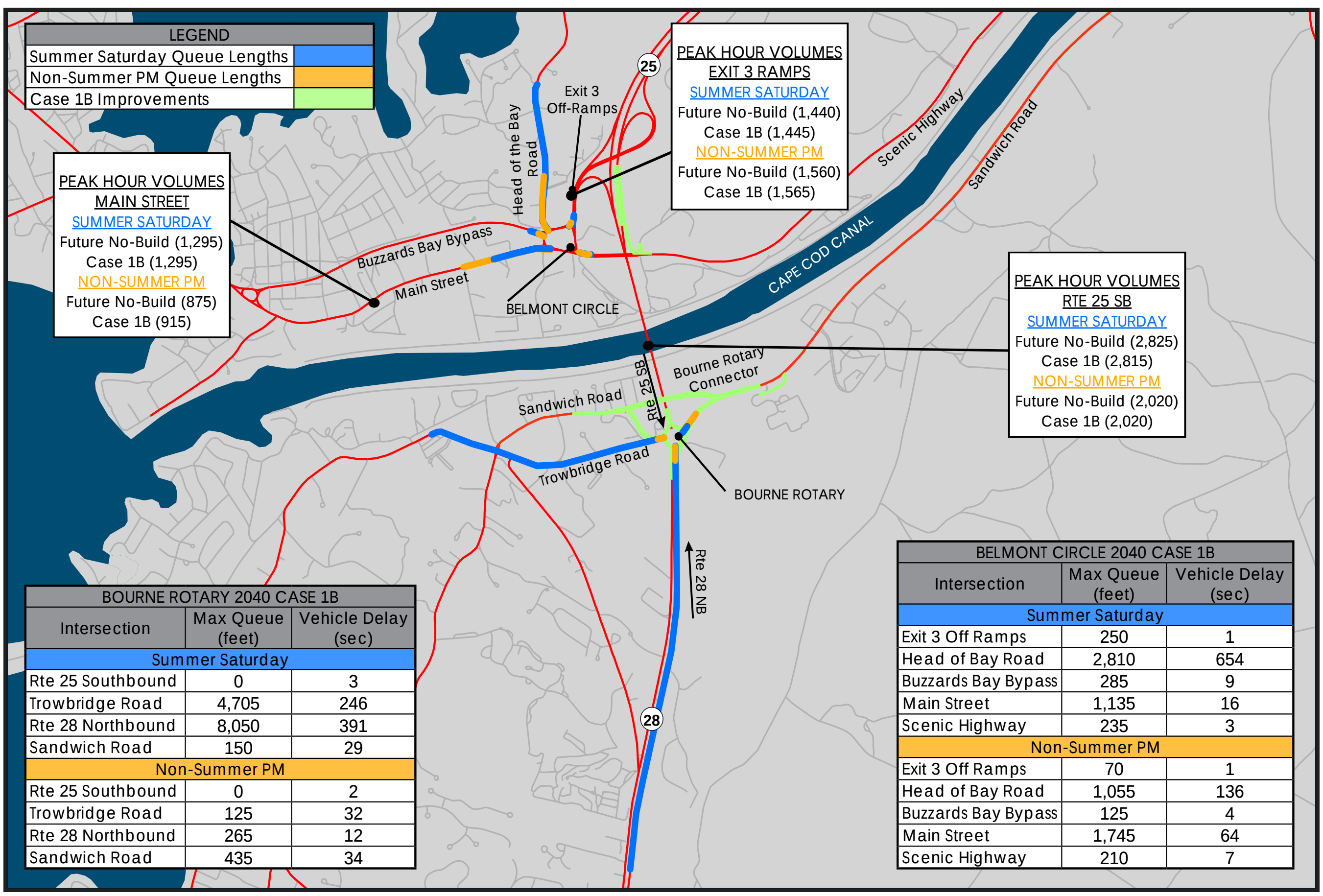
the Bourne Rotary. During the summer Saturday peak period, these queues extend nearly 9,000 feet, delaying vehicles trying to exit Route 25 to Belmont Circle. More detailed information is provided below on the forecast traffic operation at Belmont Circle and Bourne Rotary (also see Table 4-35 and Exhibit 4-32).

### *Belmont Circle*

**Result:** Overall, Case 1B would result in a moderate improvement in traffic operations at Belmont Circle. The results for the non-summer weekday and summer Saturday peak periods are inconsistent, with the most pronounced delay reductions forecast on the Main Street and Scenic Highway approaches during the summer Saturday peak period. During the non-summer weekday peak period, Head of the Bay Road is forecast to experience the greatest delay reductions.

**Cause:** With the Scenic Highway westbound to Route 25 westbound ramp as the only roadway improvements to be implemented at Belmont Circle under Case 1B, traffic operations in Belmont Circle would only moderately improve compared to the future no-build condition.

***Exhibit 4-32 Case 1B - Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***




| BOURNE ROTARY 2040 CASE 1B | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 0 | 3 |
| Trowbridge Road | 4,705 | 246 |
| Rte 28 Northbound | 8,050 | 391 |
| Sandwich Road | 150 | 29 |
| Non-Summer PM | | |
| Rte 25 Southbound | 0 | 2 |
| Trowbridge Road | 125 | 32 |
| Rte 28 Northbound | 265 | 12 |
| Sandwich Road | 435 | 34 |

| BELMONT CIRCLE 2040 CASE 1B | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 250 | 1 |
| Head of Bay Road | 2,810 | 654 |
| Buzzards Bay Bypass | 285 | 9 |
| Main Street | 1,135 | 16 |
| Scenic Highway | 235 | 3 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 70 | 1 |
| Head of Bay Road | 1,055 | 136 |
| Buzzards Bay Bypass | 125 | 4 |
| Main Street | 1,745 | 64 |
| Scenic Highway | 210 | 7 |

Table 4-35 Case 1B - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1B | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 70 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 142 (2.37) | **F** | 1,055 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 125 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 61 (1.02) | **F** | 1,745 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 7 | A | 210 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **42.8** | **E** | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 2 | A | 250 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 622 (10.37) | **F** | 2,810 (0.53) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 9 | A | 285 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 17 | C | 1,135 |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 3 | A | 235 |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **130.6 (2.18)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 2 | A | 0 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 33 | D | 125 |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 13 | B | 265 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 32 | D | 435 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **20** | **C** | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 3 | A | 0 |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 249 (4.15) | F | 4,705 (0.89) |
| Route 28 NB | 301 (5.02) | F | 4,135 (0.78) | 189 (3.15) | F | 3,605 (0.68) | 409 (6.82) | F | 8,050 (1.52) |
| Sandwich Rd WB | 27 | D | 1475 | 135 (2.25) | **F** | 6,430 (1.22) | 24 | C | 150 |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **171.25 (2.85)** | **F** | |

*Notes:*
*LOS E and LOS F movements are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

During the summer Saturday peak period, queuing and delays would decrease substantially on the Scenic Highway and Main Street approaches, while remaining about the same on the other approaches to Belmont Circle. With a forecast delay of over 11 minutes during the summer Saturday peak period (similar to the future no-build condition), the Head of the Bay Road approach would continue to be the most problematic approach. This is likely travelers bypassing Route 25 or Route 6 in Wareham and approaching Belmont Circle from Head of the Bay Road.

### *Bourne Rotary*

**Result:** Overall, traffic operations at the Bourne Rotary would improve substantially under Case 1B compared to the future no-build condition. More substantial improvement is forecast during the non-summer weekday peak period than the summer Saturday period. During the summer Saturday peak period, approaches to the Bourne Rotary that would continue to experience considerable delay include Trowbridge Road and Route 28 northbound.

**Cause:** Improvements at Bourne Rotary include modifications that would not allow traffic to cross over the north side of the Rotary. This action would allow traffic from the Route 25 southbound approach to enter freely without having to contend with traffic coming from the east side of the Rotary. This would eliminate both the non-summer weekday and non-summer Saturday peak period delays from the Route 25 southbound approach.

However, the current configuration, having vehicles circulate counter-clockwise around the Rotary results in regular gaps in the rotary traffic for vehicles entering from all approaches. Not allowing traffic to cross the top of the Rotary would result in fewer gaps for traffic entering from Trowbridge Road and Route 28 northbound, resulting in continued extended queues from those approaches during the summer Saturday peak period.

### *Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

As shown on Exhibit 4-39, under Case 1B travel conditions on the approaches to the Sagamore Bridge would be effectively unchanged for the future no-build condition during both the non-summer weekday PM and summer Saturday peak periods. Because these cases do not include improvements in the Sagamore Bridge area (including the relocation of Route 6 Exit 1C or the addition of a travel lane of Route 6 eastbound).

### 4.9.4 Case 2

Case 2 includes the following transportation improvements:

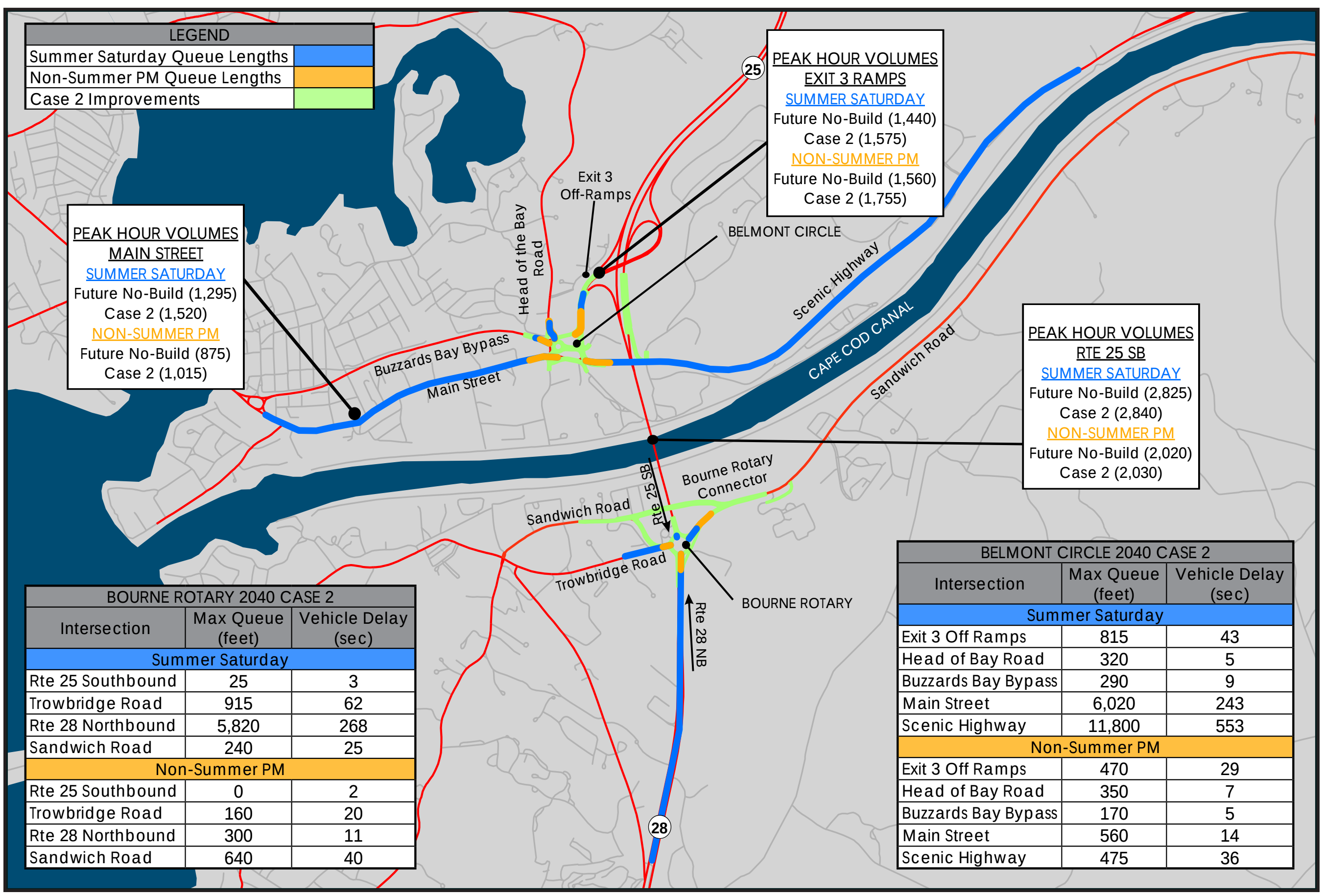
- Scenic Highway to Route 25 Westbound Ramp
- Route 6 – Relocation of Exit 1C
- Belmont Circle Reconstruction (Alternative 1 – Four-Leg Roundabout and Signalized Intersection)
- Bourne Rotary Reconstruction (Alternative 2 – Three Signalized Intersections)

This case represents the implementation of all suggested transportation improvements, prior to the assumed replacement of the Bourne and Sagamore Bridges (although these improvements would also be compatible with replacement Canal bridges). More detailed information is provided below on the forecast traffic operation at Belmont Circle and Bourne Rotary (also see Table 4-36 and Exhibit 4-33).

#### *Belmont Circle*

**Result:** Overall, implementing the Case 2 improvements would modestly improve traffic operations at Belmont Circle compared to the future no-build condition. More substantial reduction

***Exhibit 4-33 Case 2 - Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***




| BOURNE ROTARY 2040 CASE 2 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 25 | 3 |
| Trowbridge Road | 915 | 62 |
| Rte 28 Northbound | 5,820 | 268 |
| Sandwich Road | 240 | 25 |
| Non-Summer PM | | |
| Rte 25 Southbound | 0 | 2 |
| Trowbridge Road | 160 | 20 |
| Rte 28 Northbound | 300 | 11 |
| Sandwich Road | 640 | 40 |

| BELMONT CIRCLE 2040 CASE 2 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 815 | 43 |
| Head of Bay Road | 320 | 5 |
| Buzzards Bay Bypass | 290 | 9 |
| Main Street | 6,020 | 243 |
| Scenic Highway | 11,800 | 553 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 470 | 29 |
| Head of Bay Road | 350 | 7 |
| Buzzards Bay Bypass | 170 | 5 |
| Main Street | 560 | 14 |
| Scenic Highway | 475 | 36 |

Table 4-36 Case 2 - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 29 | D | 470 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 7 | A | 350 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 5 | A | 170 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 14 | B | 560 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 36 | **E** | 475 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **18.2** | **C** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 43 | E | 815 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 5 | A | 320 |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 9 | A | 290 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 243 (4.05) | **F** | 6,020 (1.14) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 553 (9.22) | **F** | 11,800 (2.23) |
| **Intersection (Overall)** | **62.6 (1.04)** | F | | **191.4 (3.19)** | F | | **170.6 (2.84)** | F | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 2 | A | 0 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 20 | C | 160 |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 11 | B | 300 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 40 | E | 640 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **18.25** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 3 | A | 25 |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 62 (1.03) | **F** | 915 |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 268 (4.47) | **F** | 5,820 (1.10) |
| Sandwich Rd WB | 27 | D | 1,475 | 135 (2.25) | **F** | 6,430 (1.22) | 25 | D | 240 |
| **Intersection (Overall)** | **159.5 (2.66)** | F | | **229.5 (3.83)** | F | | **89.5 (1.49)** | F | |

*Notes:*
*LOS E and LOS F movements are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

in queuing and delays would occur during the non-summer weekday than the summer Saturday peak period at both locations.

**Cause:** Traffic operations substantially improve under Case 2 compared to the future no-build condition during the non-summer weekday peak period. Compared to the future no-build condition, the average delay on the Head of the Bay Road approach would decrease from 317 seconds to seven seconds during the non-summer weekday peak period and from 656 seconds to five seconds during the summer Saturday peak period. All other approaches to Belmont Circle during the non-summer weekday peak period are modest (less than 30 seconds) for the future no-build condition and would remain so under Case 2.

During the summer Saturday peak period, extended queuing would persist at the Main Street and Scenic Highway approaches. The persistent queuing and delays on Main Street can be partly attributed to the increased traffic volumes of regional travelers and local residents accessing the numerous business on Main Street. During the summer Saturday peak period, traffic volumes increase 16%, from 1,295 to 1,520 vehicles per hour. As additional improvements are implemented, travelers who may have avoided Belmont Circle because of the delay, are forecast to more frequently use Main Street to access Belmont Circle.

#### *Bourne Rotary*

**Result:** Traffic operations at Bourne Rotary under Case 2 would substantially improve during the non-summer weekday peak period compared to the future no-build condition. Average delay would be less than one minute at all approaches during both the non-summer weekday and summer Saturday peak periods except for Trowbridge Road (62 seconds) and Route 28 northbound (4.5 minutes). These two approaches would continue to experience LOS F conditions during the summer Saturday peak period.

**Cause:** The new configuration of the Bourne Rotary - which doesn't allow traffic to cross over the north side of the Rotary - is forecast to improve overall traffic operations, especially during the non-summer weekday period. However, this configuration results in fewer gaps for vehicles trying to enter the Rotary from Route 28 northbound, preventing delay reductions at that approach.

#### *Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

As shown on Exhibit 4-39, under Case 2 travel conditions on the approaches to the Sagamore Bridge would be effectively the same as Case 1 for the future no-build condition during

both the non-summer weekday PM and summer Saturday peak periods. Because these cases do not include improvements in the Sagamore Bridge area (including the relocation of Route 6 Exit 1C or the addition of a travel lane of Route 6 eastbound).

### 4.9.5 Case 2B

Case 2B includes the following transportation improvements:

- Scenic Highway to Route 25 Westbound Ramp
- Route 6 – Relocation of Exit 1C
- Belmont Circle Reconstruction (Alternative 1A – Four-Leg Roundabout with Route 25 Flyover to Scenic Highway Eastbound)
- Bourne Rotary Reconstruction (Alternative 2 – Three Signalized Intersections)

Under Case 2A, a flyover ramp would allow traffic from Route 25 Exit 3 to bypass the signalized intersection on the east side of Belmont Circle and merge directly onto Scenic Highway. All improvements included in Case 2B would be implemented prior to the assumed replacement of the Bourne and Sagamore Bridges.

More detailed information is provided below on the forecast traffic operation at Belmont Circle and Bourne Rotary (also see Table 4-37 and Exhibit 4-34).

#### *Belmont Circle*

**Result:** Overall, Case 2B would result in substantially reduced queuing and delays in Belmont Circle during the non-summer weekday period with delay at all approaches less than 10 seconds, except Scenic Highway, which would only be 16 seconds. However, during the summer Saturday peak period extended queues are forecast at several approaches, including Head of the Bay Road and Buzzards Bay Bypass.

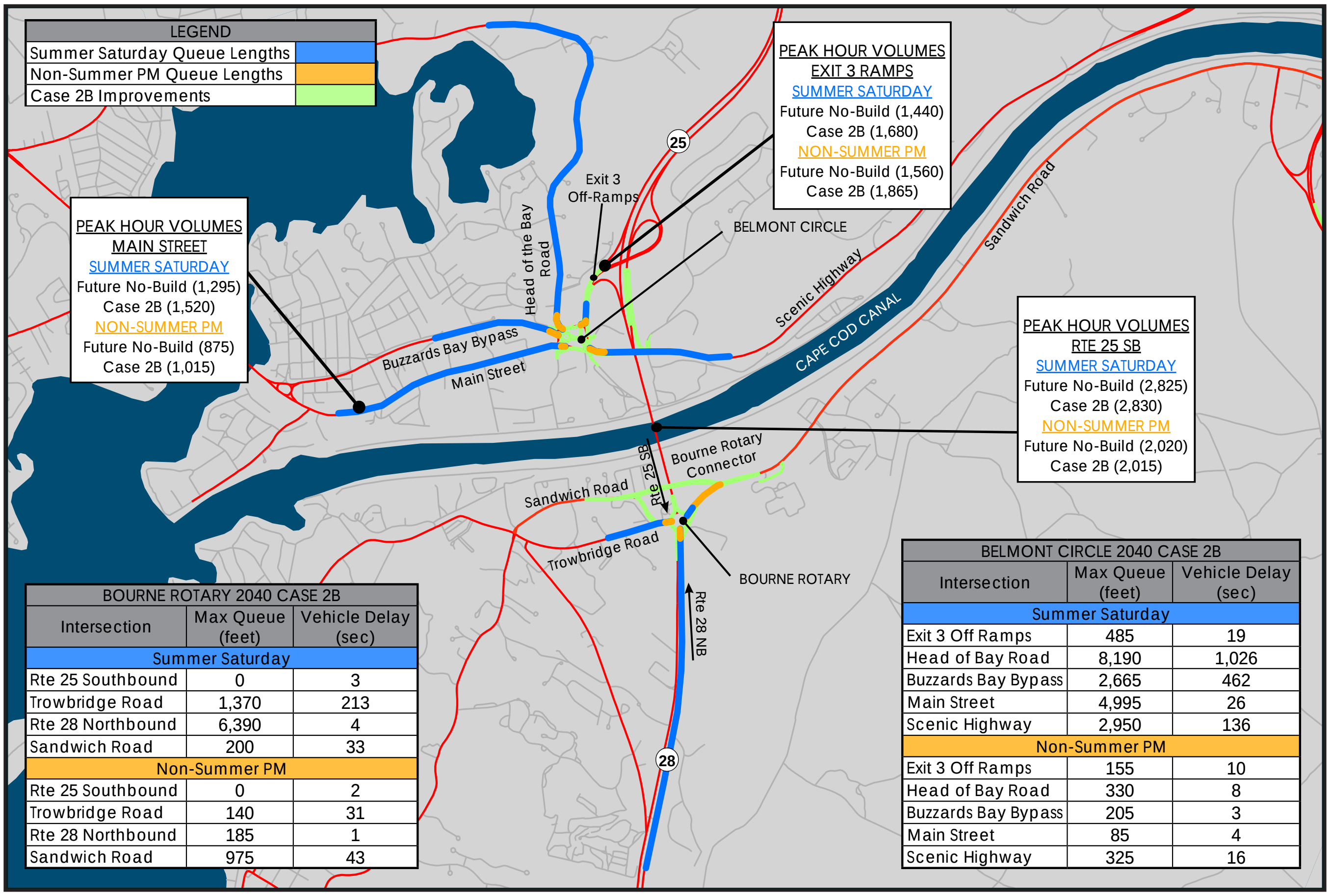
The new flyover ramp from Route 25 to Scenic Highway westbound would reduce queuing and delays at Belmont Circle, resulting in only minor delay (3-16 seconds) during the non-summer weekday peak period. However, traffic conditions during the summer Saturday peak period would be worse than the forecast future no-build conditions with extended queuing and delays at the Head of the Bay Road (15.5-minute delay) and the Buzzards Bay Bypass (7.5-minute delay).

**Cause:** The more freely flowing traffic entering the new roundabout from the Route 25 Exit 3 exit ramp results in fewer gaps between vehicles in the roundabout. This increases the difficulty for vehicles trying to enter from other approaches,

Table 4-37 Case 2B - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 2B | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 9 | A | 155 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 8 | A | 330 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 205 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 4 | A | 85 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 16 | C | 325 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **8** | **A** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 18 | C | 485 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 940 (15.67) | **F** | 8,190 (1.55) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 446 (7.43) | **F** | 2,665 (0.50) |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 45 | **E** | 4,995 (0.94) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 147 (2.45) | **F** | 2,950 (0.56) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **319.2 (5.32)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 2 | A | 0 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 17 | C | 140 |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 7 | A | 185 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 49 | **E** | 975 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **18.75** | **C** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 3 | A | 0 |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 136 (2.27) | **F** | 1370 |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 344 (5.73) | **F** | 6,930 (1.31) |
| Sandwich Rd WB | 27 | D | 1,475 | 135 (2.25) | **F** | 6,430 (1.22) | 24 | C | 200 |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **126.75 (2.11)** | **F** | |

*Notes:*
*LOS E and LOS F movements are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*




| BOURNE ROTARY 2040 CASE 2B | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 0 | 3 |
| Trowbridge Road | 1,370 | 213 |
| Rte 28 Northbound | 6,390 | 4 |
| Sandwich Road | 200 | 33 |
| Non-Summer PM | | |
| Rte 25 Southbound | 0 | 2 |
| Trowbridge Road | 140 | 31 |
| Rte 28 Northbound | 185 | 1 |
| Sandwich Road | 975 | 43 |

| BELMONT CIRCLE 2040 CASE 2B | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 485 | 19 |
| Head of Bay Road | 8,190 | 1,026 |
| Buzzards Bay Bypass | 2,665 | 462 |
| Main Street | 4,995 | 26 |
| Scenic Highway | 2,950 | 136 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 155 | 10 |
| Head of Bay Road | 330 | 8 |
| Buzzards Bay Bypass | 205 | 3 |
| Main Street | 85 | 4 |
| Scenic Highway | 325 | 16 |

***Exhibit 4-34 Case 2B - Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***

particularly the Head of the Bay Road and Main Street approaches.

As noted under Case 2, a contributing factor in the poor traffic conditions at Belmont Circle during the summer Saturday peak period includes the diversion of additional traffic to the Bourne Bridge area as overall traffic conditions in this area improve. The persistent queuing and delays on Main Street can be partly attributed to the increased traffic volumes. During the summer Saturday peak period, traffic volumes increase from 1,295 to 1,520 vehicles per hour.

### *Bourne Rotary*

**Result:** Traffic operations at Bourne Rotary under Case 2B would substantially improve during the non-summer weekday peak period compared to the future no-build condition. Average delay would be less than one minute at all approaches during both the non-summer weekday and non-summer Saturday peak periods except for Trowbridge Road (2.2 minutes) and Route 28 northbound (5.7 minutes). These two approaches would continue to experience LOS F conditions during the summer Saturday peak period.

**Cause:** The new configuration of the Bourne Rotary which would not allow traffic to cross over the north side of the Rotary would allow increased traffic flow from Route 28 southbound. This improves overall traffic operations, especially during the non-summer weekday peak period. However, during the summer Saturday peak period, this configuration results in fewer gaps for vehicles trying to enter the Rotary from Trowbridge Road and Route 28 northbound, preventing delay reductions at those approaches.

#### *Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

As shown on Exhibit 4-39, under Case 2B travel conditions on the approaches to the Sagamore Bridge would be effectively the same as Case 1 for the future no-build condition during both the non-summer weekday PM and summer Saturday peak periods. Because these cases do not include improvements in the Sagamore Bridge area (including the relocation of Route 6 Exit 1C or the addition of a travel lane of Route 6 eastbound).

### 4.9.6 Case 3

Case 3 includes the following transportation improvements:

- Scenic Highway to Route 25 Westbound Ramp
- Belmont Circle Reconstruction (Alternative 1 – Four-Leg Roundabout and Signalized Intersection)
- Bourne Rotary Reconstruction (Alternative 2 – Three Signalized Intersections)
- Sagamore Bridge Replacement
- Bourne Bridge Replacement
- Route 6 – Relocation of Exit 1C
- Route 6 – Additional Eastbound Travel Lane to Exit 2 (Route 130)

Case 3 includes all transportation improvements described under Case 2, plus several additional major transportation improvements including the assumed replacement of the Bourne and Sagamore Bridges (by the USACE) and the construction of an additional eastbound travel lane on Route 6 to Exit 2 (Route 130). Case 3 represents the implementation of nearly all suggested transportation improvements. More detailed information is provided below on the forecast traffic operation at Belmont Circle and Bourne Rotary (also see Table 4-38 and Exhibit 4-35).

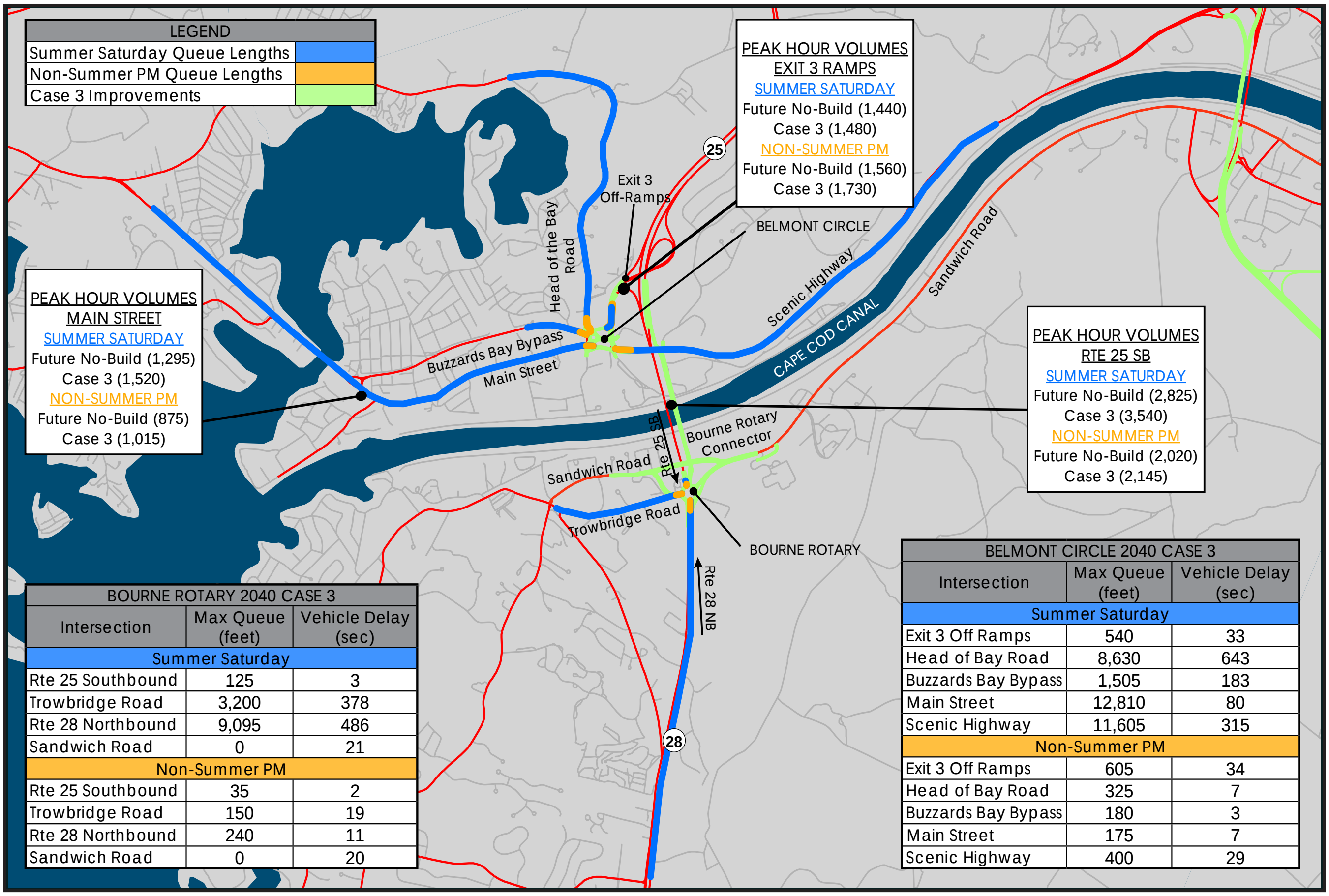
#### *Belmont Circle*

**Result:** The replacement bridges (with auxiliary lanes for entering and exiting traffic) together with the highway

Table 4-38 Case 3 - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 34 | D | 605 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 7 | A | 325 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 180 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 7 | A | 175 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 29 | D | 400 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **16** | **C** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 33 | D | 540 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 643 (10.72) | **F** | 8,630 (1.63) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 183 (3.05) | **F** | 1,505 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 80 (1.33) | **F** | 12,810 (2.43) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 315 (5.25) | **F** | 11,605 (2.20) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **250.8 (4.18)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 2 | A | 35 |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | 19 | C | 150 |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 11 | B | 240 |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 20 | C | 0 |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **13** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 3 | A | 125 |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 378 (6.3) | **F** | 3,200 (0.61) |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 486 (8.1) | **F** | 9,095 (1.72) |
| Sandwich Rd WB | 27 | D | 1,475 | 135 (2.25) | **F** | 6,430 (1.22) | 21 | C | 0 |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **222 (3.7)** | **F** | |

*Notes:*
*LOS E and LOS F movements are **bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*




| BOURNE ROTARY 2040 CASE 3 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Rte 25 Southbound | 125 | 3 |
| Trowbridge Road | 3,200 | 378 |
| Rte 28 Northbound | 9,095 | 486 |
| Sandwich Road | 0 | 21 |
| Non-Summer PM | | |
| Rte 25 Southbound | 35 | 2 |
| Trowbridge Road | 150 | 19 |
| Rte 28 Northbound | 240 | 11 |
| Sandwich Road | 0 | 20 |

| BELMONT CIRCLE 2040 CASE 3 | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 540 | 33 |
| Head of Bay Road | 8,630 | 643 |
| Buzzards Bay Bypass | 1,505 | 183 |
| Main Street | 12,810 | 80 |
| Scenic Highway | 11,605 | 315 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 605 | 34 |
| Head of Bay Road | 325 | 7 |
| Buzzards Bay Bypass | 180 | 3 |
| Main Street | 175 | 7 |
| Scenic Highway | 400 | 29 |

***Exhibit 4-35 Case 3- Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***

interchange at the existing Bourne Rotary and improvements to Belmont Circle would reduce existing vehicle conflict points and separate regional from local traffic. With these transportation improvements in place, traffic would operate substantially better during the non-summer weekday peak period at Belmont Circle compared to the future no build condition.

However, during the summer Saturday peak period, traffic operations degrade substantially, becoming worse than the future no build conditions. Average delay during the summer Saturday peak period would exceed 10.7 and 5.2 minutes at the Head of the Bay Road and Scenic Highway approaches, respectively.

**Cause:** A contributing reason for the poor traffic operations at Belmont Circle under Case 3 is that the improved roadway system in the Bourne Bridge area results in a diversion of a substantial number of additional vehicles from other locations to this area. For example, during the summer Saturday peak period, Main Street is forecast to process 225 additional vehicles (increasing from 1,295 to 1,520 vehicles).

### *Bourne Rotary*

**Result:** Traffic operations under Case 3 at the Bourne Rotary would improve substantially during the non-summer weekday peak period. Average delay for all approaches would range from two- to 20-seconds. However, during the summer Saturday peak period, delay would vary depending on the approach. The Route 25 southbound and Sandwich Road approaches would have relatively minor delay at three- and 21-seconds, respectively. Conversely, average delay during the summer Saturday peak period at the Trowbridge Road and Route 28 northbound approaches would each be worse than future no-build conditions, at 6.3 and 8.1 minutes, respectively.

**Cause:** The replacement Bourne Bridge together with the new configuration of the Bourne Rotary, which would not allow traffic to cross over the north side of the Rotary, would result in diversions of traffic to the Bourne Bridge. Under existing and future no-build conditions, traffic congestion at Belmont Circle and the Bourne Rotary discourages use of the Bourne Bridge. As traffic operations improve, traffic that currently diverts to the Sagamore Bridge is forecast to shift to the more direct route over the Bourne Bridge. Specifically, during the summer Saturday peak period, the Bourne Bridge is forecast to have an additional 715 vehicles (increasing from 2,825 to 3,540 vehicles).

These increased summer period traffic volumes, without corresponding improvements in the roadway infrastructure at the Bourne Rotary, result in fewer gaps for vehicles trying to enter the Rotary from Trowbridge Road and Route 28 northbound, preventing delay reductions at those approaches (Exhibit 4-35).

## 4.9.7 Case 3A

Case 3A includes the following transportation improvements:

- Scenic Highway to Route 25 Westbound Ramp
- Route 6 – Relocation of Exit 1C
- Belmont Circle Reconstruction (Alternative 1 – Four-Leg Roundabout and Signalized Intersection)
- Sagamore Bridge Replacement
- Bourne Bridge Replacement
- Route 6 – Additional Travel Lane to Exit 2 (Route 130)
- Bourne Rotary Reconstruction as Highway Interchange

Case 3A includes all the transportation improvements described under Case 3 plus the reconstruction of Bourne Rotary as a highway interchange.

Case 3A represents the implementation of all suggested transportation improvements. More detailed information is provided below on the forecast traffic operation at Belmont Circle and Bourne Rotary (also see Table 4-39 and Exhibit 4-36), and the Route 3 and Route 6 approaches to the Sagamore Bridge (also see Table 4-41 and Exhibit 4-37).

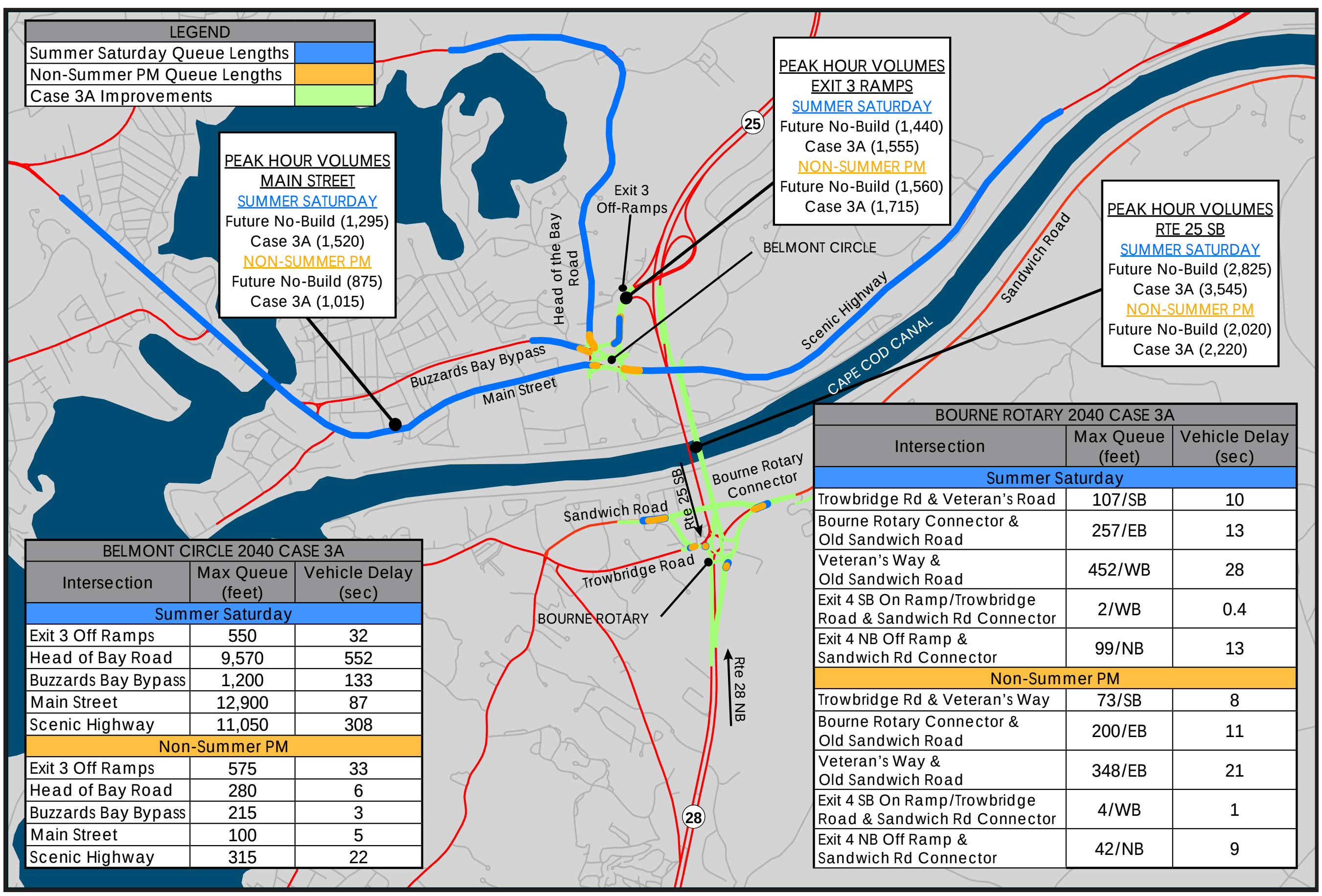
### *Belmont Circle*

**Result:** Traffic operations under Case 3A would operate substantially better at Belmont Circle during the non summer weekday peak period compared to the future no build condition. Average delay for all approaches would range from three- to 33-seconds. Traffic operations at Belmont Circle degrade during the summer Saturday peak period as the improved roadway system results in diversions of additional vehicles to the Bourne Bridge area. Average delay would be worse than the future no-build condition, with delays ranging from 0.5 minutes at the Route 25 Exit 3 Exit ramps, to 9.2 minutes at the Head of the Bay Road approach.

**Cause:** The reason for the poor performance at Belmont Circle during the summer Saturday peak period is that as overall traffic

*Text continues on page 4-95.*

***Exhibit 4-36 Case 3A - Maximum Queue and Average Delay, Belmont Circle and Bourne Rotary***




| BELMONT CIRCLE 2040 CASE 3A | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Exit 3 Off Ramps | 550 | 32 |
| Head of Bay Road | 9,570 | 552 |
| Buzzards Bay Bypass | 1,200 | 133 |
| Main Street | 12,900 | 87 |
| Scenic Highway | 11,050 | 308 |
| Non-Summer PM | | |
| Exit 3 Off Ramps | 575 | 33 |
| Head of Bay Road | 280 | 6 |
| Buzzards Bay Bypass | 215 | 3 |
| Main Street | 100 | 5 |
| Scenic Highway | 315 | 22 |

| BOURNE ROTARY 2040 CASE 3A | | |
|---|---|---|
| Intersection | Max Queue (feet) | Vehicle Delay (sec) |
| Summer Saturday | | |
| Trowbridge Rd & Veteran's Way | 107/SB | 10 |
| Bourne Rotary Connector & Old Sandwich Road | 257/EB | 13 |
| Veteran's Way & Old Sandwich Road | 452/WB | 28 |
| Exit 4 SB On Ramp/Trowbridge Road & Sandwich Rd Connector | 2/WB | 0.4 |
| Exit 4 NB Off Ramp & Sandwich Rd Connector | 99/NB | 13 |
| Non-Summer PM | | |
| Trowbridge Rd & Veteran's Way | 73/SB | 8 |
| Bourne Rotary Connector & Old Sandwich Road | 200/EB | 11 |
| Veteran's Way & Old Sandwich Road | 348/EB | 21 |
| Exit 4 SB On Ramp/Trowbridge Road & Sandwich Rd Connector | 4/WB | 1 |
| Exit 4 NB Off Ramp & Sandwich Rd Connector | 42/NB | 9 |

*Table 4-39 Case 3A - Future (2040) Traffic Operations, Belmont Circle and Bourne Rotary*

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 3A | | |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Miles)* |
| **BELMONT CIRCLE** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 33 | D | 575 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 6 | A | 280 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 215 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 5 | A | 100 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 22 | C | 315 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **13.8** | **B** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 32 | D | 550 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 552 (9.2) | **F** | 9,570 (1.81) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 133 (2.22) | **F** | 1,200 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 87 (1.45) | **F** | 12,900 (2.44) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 308 (5.13) | **F** | 11,050 (2.09) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **222.4 (3.71)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | | | |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.66) | | | |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | | | |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | | | |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **8.9** | **A** | |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | | | |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | | | |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | | | |
| Sandwich Rd WB | 27 | D | 1475 | 135 (2.25) | **F** | 6,430 (1.22) | | | |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **11** | **B** | |

*Notes:*
*LOS E and LOS F movements are* ***bold***
*EB – Eastbound, WB – Westbound, NB – Northbound, SB - Southbound*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Data not available in shaded areas. Highway interchanges not evaluated with VISSIM software*

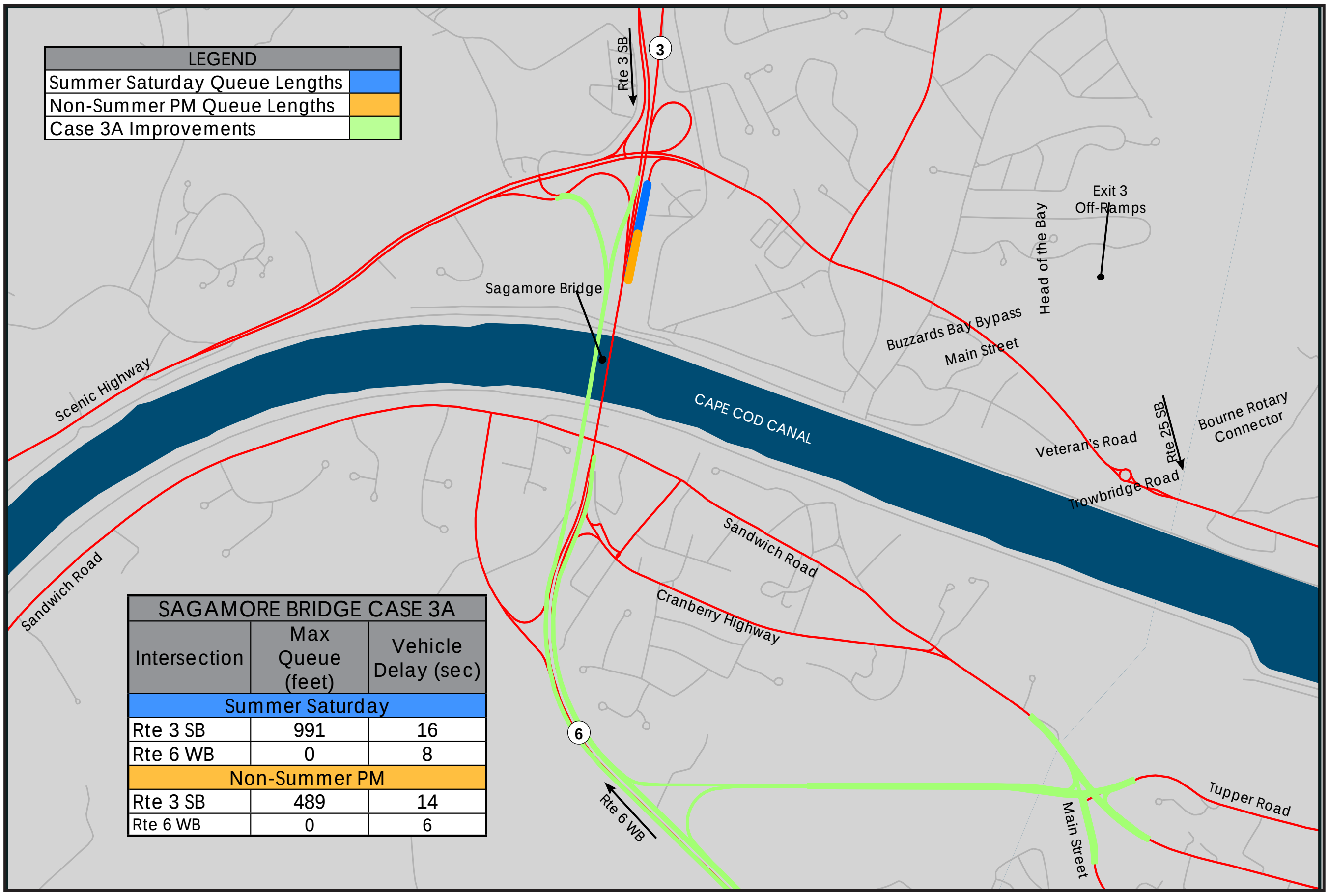



**Exhibit 4-37** *Case 3A - Maximum Queue and Average Delay, Sagamore Bridge Approaches*

*Table 4-40* *Case 3A - Future (2040) Traffic Operations, Sagamore Bridge Approaches*

| | EXISTING (2014) CONDITIONS | | | | FUTURE (2040) NO-BUILD CONDITIONS | | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* | AVERAGE DELAY *Sec (Min)* | LOS | AVERAGE QUEUE *Feet (Miles)* | MAXIMUM QUEUE *Feet (Miles)* |
| **NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM)** | | | | | | | | | | | | |
| Route 3 Southbound | 11 | B | 77 | 478 | 460 (7.7) | F | 7,481 (1.4) | 8,476 (1.6) | 14 | B | 45 | 296 |
| Route 6 Westbound | 5 | A | 53 | 232 | 178 (3.0) | F | 6,801 (1.3) | 7,967 (1.5) | 5 | A | 0 | 0 |
| **SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM)** | | | | | | | | | | | | |
| Route 3 Southbound | 416 (6.9) | F | 4,823 (0.91) | 5,393 (1.02) | 887 (14.8) | F | 22,814 (4.3) | 24,484 (4.6) | 16 | C | 581 | 990 |
| Route 6 Westbound | 683 (11.4) | F | 23,318 (4.4) | 25,014 (4.7) | 812 (13.5) | F | 24,825 (4.7) | 25,029 (4.7) | 8 | A | 0 | 0 |

*Notes:*
*LOS = Level of Service*
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*

conditions improve, additional vehicles would be diverted to the Bourne Bridge area. For example, during the summer Saturday peak period, Main Street is forecast to have 225 additional vehicles (increasing from 1,295 to 1,520 vehicles).

Further, the major improvement at the Bourne Rotary results in the elimination of queuing on the Route 25/Route 28 southbound approach to the Bourne Rotary. These southbound queues act to limit the volume of vehicles entering Belmont Circle from Route 25. With the elimination of queues on Route 25, more vehicles can freely enter Belmont Circle. This increases the difficulty for vehicles to enter the Circle from other approaches such as Head of the Bay Road and Main Street.

### *Bourne Rotary Interchange*

**Result:** Traffic operations under Case 3A would improve substantially during the non-summer weekday and summer Saturday peak periods at the Bourne Rotary Interchange. Average delay for all approaches during the non-summer Saturday peak period would range from one- to 21-seconds. During the summer Saturday peak period, delay would also be modest with average delay ranging from one- to 28-seconds (Table 4-40).

**Cause:** The interchange design allows the free-flow of vehicles on Route 28 with local traffic on Sandwich Road and Trowbridge Road directed under and over Route 28 to signalized intersections.

### *Sagamore Bridge Approaches - Route 3 Southbound and Route 6 Westbound*

**Result:** On the highway approaches to the Sagamore Bridge on Routes 3 and Route 6, the construction of an additional eastbound travel lane, combined with the relocation of Route 6 Exit 1C and assumed replacement Canal Bridges would result in substantial improvements compared to the no-build condition.

Compared to the future no-build condition, the average delay on Route 6 westbound would be reduced from 3.0 minutes to five seconds during the non-summer weekday peak period. During the summer Saturday peak period, the delay on Route 6 westbound would be reduced from 13.5 minutes to eight seconds. Delay on Route 3 southbound would experience similar delay reductions compared to the future no-build condition. Delay would drop from 7.7 minutes to 14 seconds and 14.8 minutes to 16 seconds for the non-summer weekday and summer Saturday peak periods, respectively.

**Cause:** The highway and bridge improvements proposed under Case 3A would provide the capacity and design features necessary

to safely accommodate non-summer weekday PM and summer Saturday peak period traffic volumes in 2040 and beyond. The additional westbound travel lane on Route 6 eastbound would provide additional highway capacity. The northbound and southbound auxiliary lanes envisioned on the replacement Sagamore Bridge would allow vehicles to safely enter and exit the highway without causing additional congestion.

### 4.9.8 Overall Findings of Transportation Demand Modeling Analysis

After review of the results of the seven travel demand modeling cases, overall conclusions of their effectiveness in improving traffic operations within the study area were reached. Because the modeling cases provide a reflection of traffic conditions throughout the focus area, this analysis is predominately based on how the cases would affect traffic operations at Belmont Circle, Bourne Rotary, and the Route 3 and Route 6 approaches to the Sagamore Bridge.

In developing the overall findings, the study team remained mindful of the design assumptions that guided the alternatives development process (see Section 4.1). These design assumptions include maintaining a focus on the future year-round problem locations, prioritizing improvements to accommodate the future non-summer weekday peak period and providing further improvements to accommodate the summer Saturday peak period, as feasible.

The following tables and exhibits summarize findings for the seven cases analyzed. Table 4-41 provides a summary of the primary measures of effectiveness for traffic operations at Belmont Circle and Bourne Rotary, including average queues, maximum queues, average delays, and LOS.

Exhibits 4-38 and 4-39 provide a comparison of the average delays at Belmont Circle, Bourne Rotary and the Sagamore Bridge approaches during the non-summer weekday period and summer Saturday peak periods for the future no-build condition and each of the seven cases analyzed.

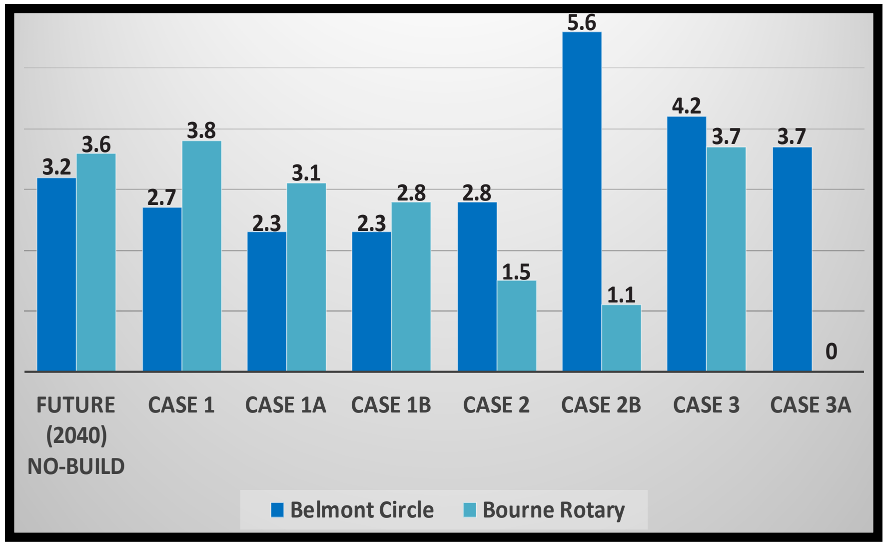
The following is a summary of the overall findings the for regional transportation modeling case analyses for the roadways within the vicinity of the Bourne and Sagamore Bridges. This analysis is divided into cases that include replacement Canal bridges and those that do not.

*Table 4-41 Summary of Case Analysis for Queues, Delay, and LOS at Belmont Circle and Bourne Rotary*

| | EXISTING (2014) CONDITIONS | | | FUTURE (2040) NO-BUILD CONDITIONS | | | FUTURE (2040) BUILD CONDITIONS - BUILD CASE 1 | | | FUTURE (2040) BUILD CASE 1A | | | FUTURE (2040) BUILD CASE 1B | | | FUTURE (2040) BUILD CASE 2 | | | FUTURE (2040) BUILD CASE 2B | | | FUTURE (2040) BUILD CASE 3 | | | FUTURE (2040) BUILD CASE 3A | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* | AVERAGE DELAY *Sec (Min)* | LOS | 95% QUEUE *Feet (Mile)* |
| **BELMONT CIRCLE** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exit 3 Off Ramps SB | 5 | A | 515 | 2 | A | 645 | 1 | A | 65 | 1 | A | 80 | 1 | A | 70 | 29 | D | 470 | 9 | A | 155 | 34 | D | 605 | 33 | D | 575 |
| Head of Bay Rd SB | 15 | C | 270 | 317 (5.28) | **F** | 1,780 | 35 | D | 520 | 30 | D | 550 | 142 (2.37) | **F** | 1,055 | 7 | A | 350 | 8 | A | 330 | 7 | A | 325 | 6 | A | 280 |
| Buzzards Bay Bypass EB | 3 | A | 100 | 3 | A | 110 | 3 | A | 85 | 3 | A | 95 | 3 | A | 125 | 5 | A | 170 | 3 | A | 205 | 3 | A | 180 | 3 | A | 215 |
| Main Street EB | 13 | B | 530 | 29 | D | 1,245 | 27 | D | 1,085 | 24 | C | 1,115 | 61 (1.02) | **F** | 1,745 | 14 | B | 560 | 4 | A | 85 | 7 | A | 175 | 5 | A | 100 |
| Scenic Highway WB | 7 | A | 380 | 14 | B | 840 | 1 | A | 60 | 1 | A | 75 | 7 | A | 210 | 36 | **E** | 475 | 16 | C | 325 | 29 | D | 400 | 22 | C | 315 |
| **Intersection (Overall)** | **8.6** | **A** | | **73 (1.22)** | **F** | | **13.4** | **B** | | **11.8** | **B** | | **42.8** | **E** | | **18.2** | **C** | | **8** | **A** | | **16** | **C** | | **13.8** | **B** | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exit 3 Off Ramps SB | 4 | A | 510 | 3 | A | 1,025 | 2 | A | 280 | 2 | A | 435 | 2 | A | 250 | 43 | **E** | 815 | 18 | C | 485 | 33 | D | 540 | 32 | D | 550 |
| Head of Bay Rd SB | 83 (1.38) | **F** | 570 | 656 (10.93) | **F** | 2,700 (0.51) | 451 (7.52) | **F** | 2,100 | 337 (5.62) | **F** | 1,640 | 622 (10.37) | **F** | 2,810 (0.53) | 5 | A | 320 | 940 (15.67) | **F** | 8,190 (1.55) | 643 (10.7) | **F** | 8,630 (3.4) | 552 (9.2) | **F** | 9,570 (3.8) |
| Buzzards Bay Bypass EB | 19 | C | 335 | 11 | B | 305 | 12 | B | 305 | 14 | B | 370 | 9 | A | 285 | 9 | A | 290 | 446 (7.43) | **F** | 2,665 (0.50) | 183 (3.1) | **F** | 1,505 | 133 (2.2) | **F** | 1200 |
| Main Street EB | 82 (1.36) | **F** | 5,755 (1.09) | 126 (2.1) | **F** | 6,140 (1.16) | 185 (3.08) | **F** | 6,140 (1.16) | 172 (2.87) | **F** | 6,140 (1.16) | 17 | C | 1,135 | 243 (4.05) | **F** | 6,020 (1.14) | 45 | **E** | 4,995 (0.94) | 80 (1.3) | **F** | 12,810 (5.1) | 87 (1.5) | **F** | 12,900 (5.2) |
| Scenic Highway WB | 125 (2.08) | **F** | 10,605 (2.01) | 161 (2.68) | **F** | 11,610 (2.20) | 154 (2.57) | **F** | 10,630 (2.01) | 154 (2.57) | **F** | 10,525 (1.99) | 3 | A | 235 | 553 (9.22) | **F** | 11,800 (2.23) | 147 (2.45) | **F** | 2,950 (0.56) | 315 (5.3) | **F** | 11,605 (4.6) | 308 (5.1) | **F** | 11,050 (4.4) |
| **Intersection (Overall)** | **62.6 (1.04)** | **F** | | **191.4 (3.19)** | **F** | | **160.8 (2.68)** | **F** | | **135.8 (2.26)** | **F** | | **130.6 (2.18)** | **F** | | **170.6 (2.84)** | **F** | | **319.2 (5.32)** | **F** | | **250.8 (4.2)** | **F** | | **222.4 (3.7)** | **F** | |
| **BOURNE ROTARY** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NON-SUMMER WEEKDAY PM PEAK PERIOD (4:00 - 6:00 PM) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Route 25 SB | 19 | C | 650 | 14 | B | 620 | 17 | C | 65 | 30 | D | 1,065 | 2 | A | 0 | 2 | A | 0 | 2 | A | 0 | 2 | A | 35 | | | |
| Trowbridge Rd EB | 75 (1.25) | **F** | 840 | 394 (6.57) | **F** | 3,465 (0.65) | 456 (7.6) | **F** | 520 | 378 (6.3) | **F** | 3,420 (0.65) | 33 | D | 125 | 20 | C | 160 | 17 | C | 140 | 19 | C | 150 | | | |
| Route 28 NB | 14 | B | 340 | 102 (1.7) | **F** | 1,275 | 67 (1.12) | **F** | 85 | 17 | C | 325 | 13 | B | 265 | 11 | B | 300 | 7 | A | 185 | 11 | B | 240 | | | |
| Sandwich Rd WB | 20 | C | 1,530 | 19 | C | 855 | 18 | C | 1,085 | 29 | D | 1,265 | 32 | D | 435 | 40 | E | 640 | 49 | E | 975 | 20 | C | 0 | | | |
| **Intersection (Overall)** | **32** | **D** | | **132.25 (2.20)** | **D** | | **139.5 (2.33)** | **F** | | **113.5 (1.89)** | **F** | | **20** | **C** | | **18.25** | **B** | | **18.75** | **C** | | **13** | **B** | | | | |
| SUMMER SATURDAY PEAK PERIOD (10:00 AM - 12:00 PM) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Route 25 SB | 280 (4.67) | **F** | 8,885 (1.68) | 329 (5.48) | **F** | 9,935 (1.88) | 333 (5.55) | **F** | 10,000 (1.89) | 337 (5.62) | **F** | 10,170 (1.93) | 3 | A | 0 | 3 | A | 25 | 3 | A | 0 | 3 | A | 125 | | | |
| Trowbridge Rd EB | 30 | D | 335 | 265 (4.42) | **F** | 2,225 | 152 (2.53) | **F** | 1,525 | 213 (3.55) | **F** | 1,645 | 249 (4.15) | **F** | 4,705 (0.89) | 62 (1.03) | **F** | 915 | 136 (2.27) | **F** | 1,370 | 378 (6.3) | **F** | 3,200 (1.3) | | | |
| Route 28 NB | 301 (5.02) | **F** | 4,135 (0.78) | 189 (3.15) | **F** | 3,605 (0.68) | 280 (4.67) | **F** | 5,375 (1.02) | 13 | B | 445 | 409 (6.82) | **F** | 8,050 (1.52) | 268 (4.47) | **F** | 5,820 (1.10) | 344 (5.73) | **F** | 6,930 (1.31) | 486 (8.1) | **F** | 9,095 (3.6) | | | |
| Sandwich Rd WB | 27 | D | 1,475 | 135 (2.25) | **F** | 6,430 (1.22) | 139 (2.32) | **F** | 6,095 (1.15) | 198 (3.3) | **F** | 9,700 (1.84) | 24 | C | 150 | 25 | D | 240 | 24 | C | 200 | 21 | C | 0 | | | |
| **Intersection (Overall)** | **159.5 (2.66)** | **F** | | **229.5 (3.83)** | **F** | | **226 (3.77)** | **F** | | **190.25 (3.17)** | **F** | | **171.25 (2.85)** | **F** | | **89.5 (1.49)** | **F** | | **126.75 (2.11)** | **F** | | **222 (3.7)** | **F** | | | | |

*Notes:*
*LOS E and LOS F movements for the existing and future no-build problem locations are* **bold**
*Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles.*
*Data not available for Case 3A at Bourne Rotary. As a highway interchange, analysis at this location was completed with Synchro software, not VISSIM™ software as was used for other locations.*
*Results for Case 3A for the intersections adjacent to the Bourne Rotary Interchange are shown on Table 4-29*

Summer Saturday Overall Average Delays (minutes)




Non-Summer PM Overall Average Delays (minutes)

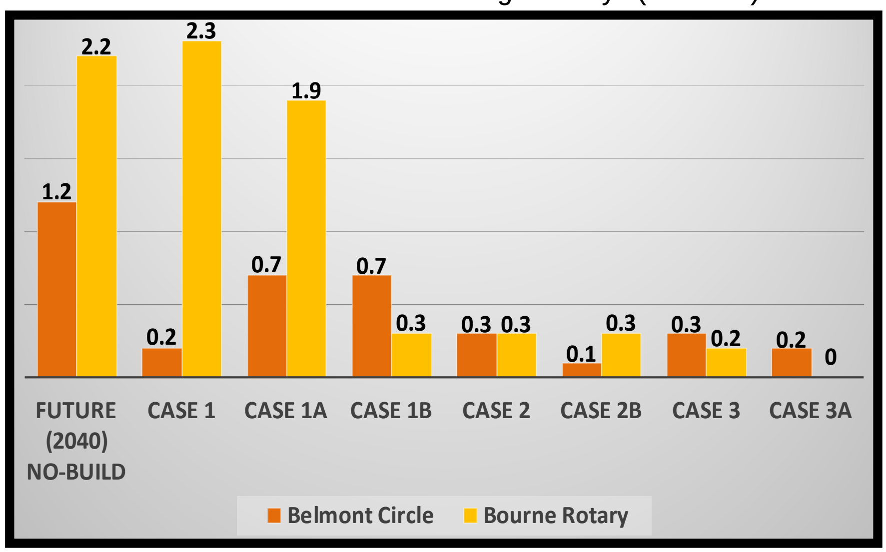


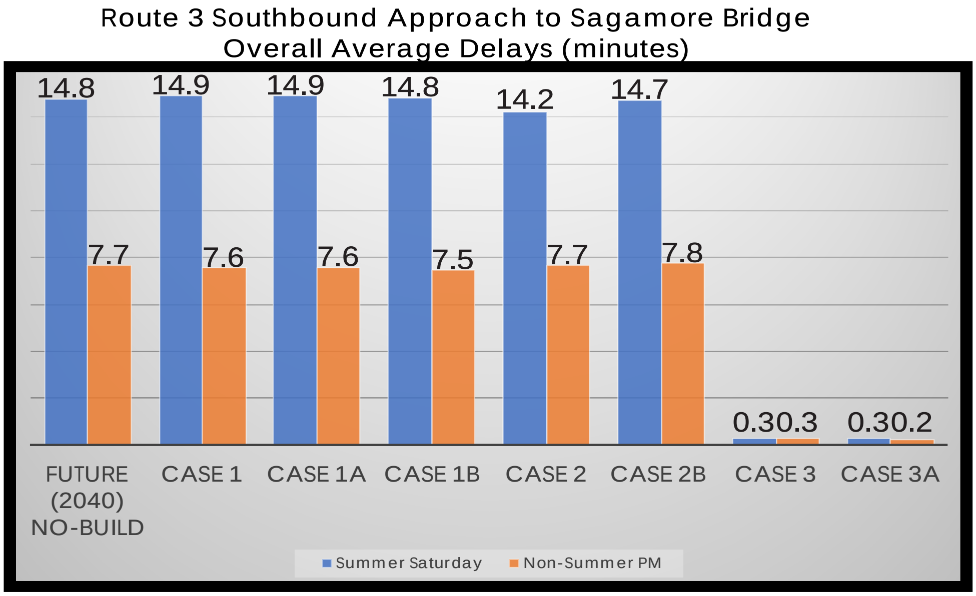

***Exhibit 4-38 Average Non-Summer Weekday and Summer Saturday Peak Period Delay, Belmont Circle and Bourne Rotary***

### *Cases 1, 1A, 1B, 2, and 2B (Cases without replacement Canal bridges) - Bourne Bridge Area*

**Non-Summer Weekday Peak Period:** Modest reductions in average delay during the non-summer weekday peak period can be achieved at Belmont Circle and Bourne Rotary with Case 1 and Case 1A when compared to the future no-build condition. Belmont Circle under Case 1 experiencing greater delay reduction.

More substantial reduction in delays can be achieved at Belmont Circle and Bourne Rotary with Case 1B and Case 2 improvements. Case 2B is also very effective during non-summer weekdays.

**Summer Saturday Peak Period:** More modest delay reductions can be achieved at Belmont Circle and Bourne Rotary under Case



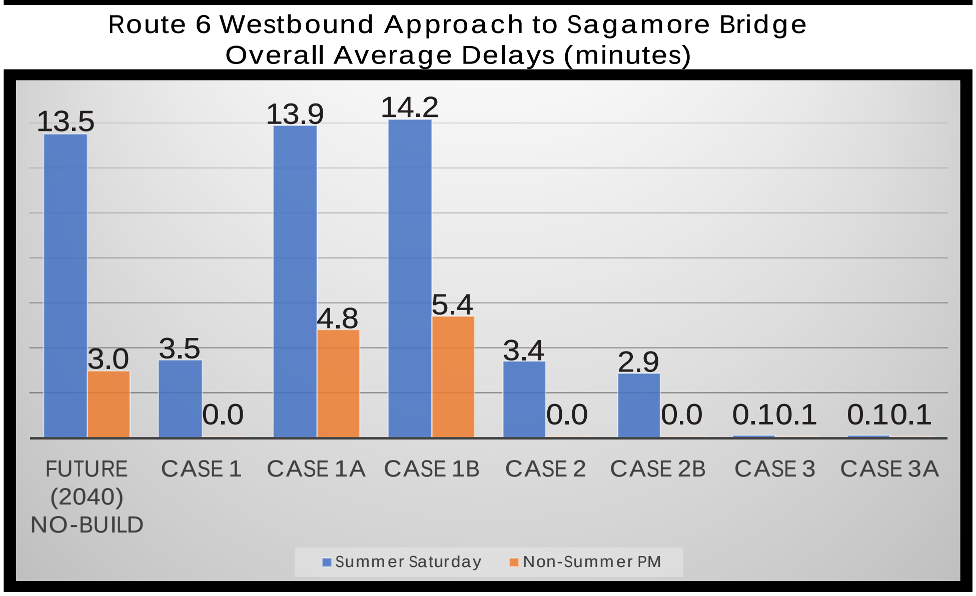




***Exhibit 4-39 Average Non-Summer Weekday and Summer Saturday Peak Period Delay, Sagamore Bridge Approaches***

1A, Case 1B, and Case 2. Case 2 would provide the greatest delay reduction at Bourne Rotary.

Roadway approaches to Belmont Circle that would continue to experience some delays during summer Saturday peak periods under these cases include Head of the Bay Road, Main Street, and Scenic Highway. Other than the Head of the Bay Road approach, Case 1B operates the best during the summer Saturday peak period among all the cases at Belmont Circle.

Roadway approaches to Bourne Rotary that would continue to experience some delays under these cases include Route 28 northbound and Trowbridge Road. Case 2 operates the best at Bourne Rotary among all the cases.

Overall, delay reduction in the Bourne Bridge area is dampened because, as roadway improvements are implemented, diversions of traffic to this area would occur. For example, under Case 2, compared to the 2040 no-build condition, peak hour volumes on Main Street would increase by 17% (1,295 to 1,520 vehicles) during the non-summer PM and by 16% during summer Saturdays.

### *Cases 1, 1A, 1B, 2, and 2B (Cases without replacement Canal bridges) - Sagamore Bridge Area*

**Non-Summer Weekday Peak Period:** With the relocation of Route 6 Exit 1C under Case 1 and Case 2, a substantial reduction in delay can be achieved on the Route 6 westbound approach to the Sagamore Bridge during non-summer weekday peak period. Average delay would be reduced from three minutes to two seconds when compared to the future no-build condition. The delay during the summer Saturday peak period on Route 3 southbound for these cases would be reduced from 13.5 minutes to 3.5 minutes. These delay reductions do not occur under Cases 1A and 1B because they do not include the relocation of Exit 1C.

The Route 3 southbound approaches to the Sagamore Bridge would not see any reductions during delay for the non-summer weekday peak period under Cases 1, 1A, 1B, 2, and 2B with average delay remaining at approximately 7.5 minutes. Under these cases no transportation improvements would be implemented that would divert traffic from Route 3 southbound during the non-summer weekday peak period.

**Summer Saturday Peak Period:** A substantial reduction in delay under Case 1 and Case 2 can also be achieved on the Route 6 westbound approach to the Sagamore Bridge during the summer Saturday peak period, with average delay being reduced from 13.5 minutes to 3.4 minutes. These delay reductions do not occur under Cases 1A and 1B because they do not include the relocation of Exit 1C.

The Route 3 southbound approaches to the Sagamore Bridge would not see any reductions in delay during summer Saturday peak period under Cases 1, 1A, 1B, 2, and 2B with average delay remaining at approximately 15 minutes. Under these cases no transportation improvements would be implemented that would divert traffic from Route 3 southbound during the summer Saturday peak period.

### *Cases 3 and 3A (Cases with replacement Canal bridges) – Bourne Bridge Area*

**Non-Summer Weekday Peak Period:** Cases 3 and 3A include the assumed replacement Canal bridges, the relocation of Route 6

Exit 1C, and an additional Route 6 eastbound travel lane. Both Belmont Circle and Bourne Rotary would operate well with average delays ranging from two to 34 seconds on the various roadway approaches. Few delays would be experienced during the non-summer weekday peak period.

**Summer Saturday Peak Period:** Traffic would operate worse than the future no-build conditions at both Belmont Circle and Bourne Rotary under Case 3. Extended queuing and delays would be experienced at the Scenic Highway, Main Street, and Head of the Bay Road approaches to Belmont Circle.

Under Case 3A (which differs from Case 3 with the construction of a highway interchange replacing the Bourne Rotary), the Bourne Rotary area would operate with very few delays. Belmont Circle however, would continue to suffer from extended queuing at several approaches.

### *Cases 3 and 3A (Cases with replacement Canal bridges) – Sagamore Bridge Area*

**Non-Summer Weekday Peak Period:** Implementation of the improvements proposed under Cases 3 and 3A would result in a substantial reduction in delay on the Route 6 westbound approach to the Sagamore Bridge during the non-summer weekday peak period. Average delay would be reduced from three minutes to six seconds, when compared to the future no-build condition.

The Route 3 southbound approaches to the Sagamore Bridge are also forecast to experience a substantial reduction in delay during the non-summer weekday peak period under both Cases 3 and 3A, with average delay being reduced from 7.6 minutes to 14 seconds.

**Summer Saturday Peak Period:** Under Cases 3 and 3A, a substantial reduction in delay can also be achieved on the Route 6 westbound approach to the Sagamore Bridge during the summer Saturday peak period, with average delay being reduced from 13.5 minutes to only eight seconds.

The Route 3 southbound approaches to the Sagamore Bridge are forecast to experience a substantial reduction in delay during the summer Saturday peak period under both Cases 3 and 3A, with average delay being reduced from 14.7 minutes to 16 seconds.

## 4.10 ADDITIONAL STUDY ANALYSIS

The following sections describe the results of the additional analysis conducted for the travel demand model cases to determine the degree of impact and/or benefit to air quality, highway noise, and economic conditions.

The preliminary air quality and noise evaluations were conducted based on the potential location of roadway and traffic forecasts for Case 2 and Case 3A. These two cases were chosen because they represent the most complete cases involving in which the existing Canal bridges remain and those in which replacement bridges replacement Canal bridges and those that replacement Canal bridges are in place. These cases represent the maximum potential air quality and highway noise impact.

### 4.10.1 Air Quality Evaluation

A preliminary air quality evaluation was conducted based on the conceptual design of potential transportation improvements and future traffic forecasts. As such, the study did not include roadway prediction modeling of air quality levels with the U.S. Environmental Protection Agency (EPA) and FHWA approved air quality models. Instead, a more qualitative evaluation was conducted to assess the potential for increased or decreased air quality impacts within the study area utilizing EPA and FHWA guideline criteria. The complete preliminary air quality analysis can be reviewed in Appendix F.

A detailed air quality study would be conducted during the preparation of an environmental document for future projects. These future detailed air quality analyses would evaluate existing and future air quality impacts associated with project roadways. Impact would be assessed with respect to the methodologies and assumptions for each pollutant consistent with FHWA and EPA guidance as well as that of the MassDOT and Massachusetts Department of Environmental Protection (MassDEP).

A qualitative carbon monoxide (CO), Mobile Source Air Toxics (MSATs), VOCs/NOX, and greenhouse gas (GHG) analysis was conducted. Below is a summary of the preliminary air quality evaluation. The complete preliminary air quality analysis can be reviewed in Appendix F.

#### *Preliminary Air Quality Evaluation Findings*

**Carbon Monoxide (CO):** Typically, CO is used in microscale studies to indicate roadway pollutant levels since it is the most abundant pollutant emitted by motor vehicles and can result in so-called "hot spot" (high concentration) locations around congested intersections.

A total of twelve intersections were included in the analysis, which were comprised of both existing and future intersections. In general, the LOS for the Peak AM and PM conditions are approximately the same for Case 2 and Case 3A, when compared to the future No Build conditions. Similarly, the intersection Peak AM and PM delay, volumes and VHT also generally increased for the two cases compared to the future no-build conditions. There were only a few intersections where the LOS, peak period volumes and delay were expected to improve under Case 2A or Case 3A, compared to the future no-build.

Overall, it can therefore reasonably be concluded that implementation of Case 2 or Case 3A could increase traffic volumes and delay at most of the 12 intersections evaluated, which could result in an increase of CO emissions compared to the future no-build conditions.

**Mobile Source Air Toxics (MSAT):** MSATs include a large suite of pollutants emitted from motor vehicles, airplanes, locomotives, and other engine-powered transportation modes. The forecast in increase in average daily traffic (ADT), which would result in an increase in vehicle miles traveled (VMT), would lead to overall higher MSAT emissions in the study area for the Build Alternatives.

However, regardless of the option chosen, vehicle emissions would likely be lower than present levels because of the U.S. EPA's national air quality control programs mandated under the federal Clean Air Act. These programs are projected to reduce annual MSAT emissions by over 90% between 2010 and 2050. Note that local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

**VOCs/NOX:** A mesoscale analysis was performed to calculate the potential regional air quality impact of future projects using a measure of the total daily emissions of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) within the study area. Calculations were performed to compare area-wide emissions for future build scenarios with the existing and future no-build conditions. Typically, emission factors for each pollutant are generated for each roadway link using the EPA emission models based on vehicle miles traveled, vehicle speeds and other roadway data relative to the proposed cases.

As summer ADT is expected to slightly increase with Case 2 and Case 3A compared to the future no-build condition, overall

emissions of VOCs and NOx could also slightly increase with the implementation of the projects that make up these cases. Given the relatively small expected ADT increase associated with the cases of approximately two percent and 1.5 percent relative to the total VMT's in the region, it is unlikely that this would result in a substantial change in emissions or any subsequent direct or indirect impacts to the mesoscale analysis.

**Greenhouse Gases:** The transportation system is a critical component of Massachusetts' infrastructure and contributes over one third of the Commonwealth's greenhouse gas (GHG) emissions. The Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, released the Massachusetts Clean Energy and Climate Plan for 2020. This implementation plan establishes targets for overall, statewide GHG emissions:

- By 2020, 20% reduction below statewide 1990 GHG emission levels;
- By 2050, 80% reduction below statewide 1990 GHG emission levels

MassDOT's Healthy Transportation Policy Directive, released in September 2013, includes the primary goals of reducing GHG emissions; promoting the healthy transportation modes of walking, bicycling, and public transit; and supporting smart growth development. The Cape Cod Regional Transportation Plan (RTP) reflects the vision of the Healthy Transportation Policy Directive Policy with the Multimodal Options/Healthy Transportation Goal, including a performance measure reflecting the state Mode Shift Goal. The Cape Cod Commission conducted a GHG analysis as part of the 2016 Regional Transportation Plan[2]. Anticipated GHG impacts from nine specific regional target projects were conducted. Two of those projects, Belmont Circle/Route 25 Ramp Improvements and Route 6 Exit 1C reconfiguration were included in the GHG analysis. The results of the anticipated GHG impacts from these two projects were documented as "quantified decrease in emissions from traffic operation improvement-to be verified by statewide modeling".

Overall, even with the larger improvements proposed under Case 3A, potential impact to air quality would be minor and Barnstable County is forecast to remain in attainment, based on the current National Ambient Air Quality Standards (NAAQS).

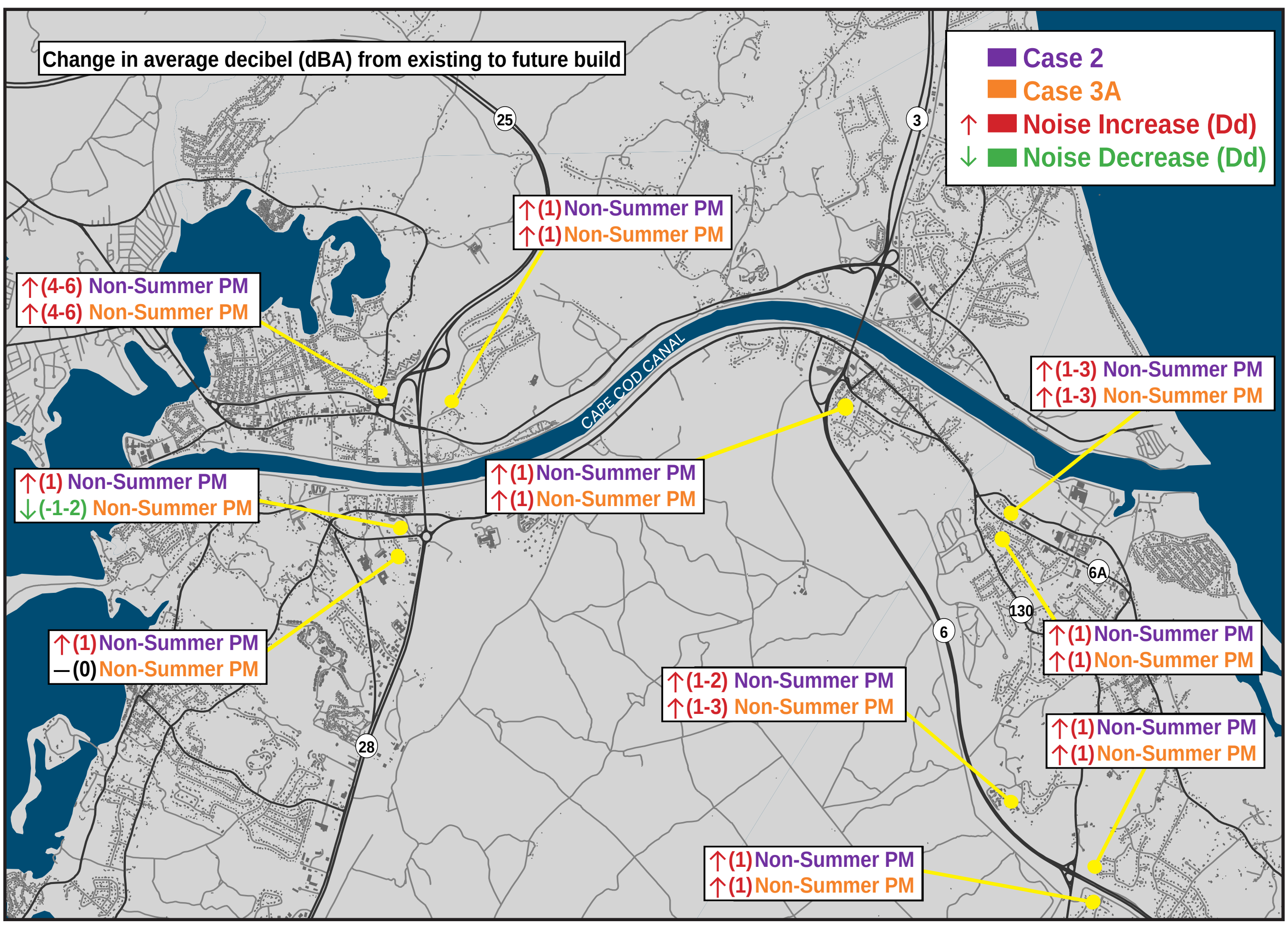
2 http://www.capecodcommission.org/resources/transportation/rtp/2016/FinalReport/Appendices/RTP%20Appendix%20N%20-%20Greenhouse%20Gas%20Analysis%20(Endorsed%207-20-15).pdf

### 4.10.2 Preliminary Noise Evaluation

FHWA and MassDOT regulations and policies require noise assessments to evaluate future equivalent noise levels in decibels (dB) during the loudest hour of the day (known as Leq dBA). The worst-case existing and future traffic conditions (i.e. highest traffic volumes found during the summer Saturday peak period) were used to correlate to higher (i.e. worst case) noise impacts at noise sensitive locations (mostly residential neighborhoods).

The increases in the hourly sound level from the 2014 Existing to 2040 Build conditions were computed for all three peak hours for Cases 2 and 3A. The range of increases and the peak hour with the highest increase are reported for the areas near residential land use. For reference, a sound level increase of three dB or less is generally not noticeable under most circumstances. An increase of five dB is generally noticeable in a community setting. An increase of 10 dB is perceived by most people as about twice as loud. Also, MassDOT' s Noise Policy considers an increase of 10 dB or more above existing noise levels to be a "substantial increase." This is a more impactful noise increase that would require consideration of abatement in a final environmental document.

***Exhibit 4-40 Preliminary Noise Analysis***



The predicted sound level increases are small for most roadways, generally less than three decibels, which is expected to be generally not noticeable (Exhibit 4-40). However, due to expected changes in traffic patterns, the Head of the Bay Road adjacent to Belmont Circle is predicted to experience up to four-fold increases in traffic volumes in both Cases 2 and 3A, which would result in increases up to six decibels. These are expected to be readily noticeable, but not approach a 'substantial increase' per MassDOT policy.

The complete preliminary noise evaluation is provided in Appendix G.

### 4.10.3 Economic Analysis

Transportation improvements can affect social and economic conditions within the local area and region in which they occur in several ways. They can improve or constrain physical access to existing commercial and residential uses. They can also open land for potential development where access did not exist or was limited prior to the implementation of the transportation improvements. In the case of the alternatives under consideration (discussed in terms of groups of alternatives, known as 'cases'), physical access is essentially maintained for existing uses and currently vacant land. This type of social and economic effect, which may include impacts on property values, is therefore limited and not measured in this analysis.

There are also social and economic benefits to reducing crashes because of the roadway geometry, shoulder widths, and other design characteristics of the transportation improvements. Benefits may also accrue because of operational improvements in signalization and other traffic control measures. While such benefits are important and discussed in Sections 4.4 through 4.6, they will not be sufficiently quantified in this planning study to allow for economic measures of their magnitude.

An additional class of social and economic effects of transportation improvements, and often the most significant from a social and economic impact standpoint, are changes in accessibility. Accessibility has three components with direct social and economic consequences: travel times, vehicle miles travelled, and mode choices. In this study, travel time differences between the existing and future no-build conditions, and the proposed 'cases' represent the primary measurable social and economic effects of alternatives.

The analyses which follow compare the differences in travel times between alternative cases derived in the traffic demand model. The analyses then estimate the dollar value of those

changes using commonly accepted measures of the value of time found in transportation literature. Finally, the economic analysis compares the annualized value of travel time savings to the annualized cost of the alternative transportation investments.

### *Travel Time Savings*

Travel time savings can benefit local and regional economies in several ways:

- Reduction in commuting times benefits workers by increasing the amount of time they can spend in more pleasurable and/or more productive activities than commuting.
- It can boost the productivity of labor – travel time savings increase output per hour because workers are less stressed by their commute, more focused and able to spend more time on work tasks.
- Business productivity is boosted by increasing the effective reach of a business to its potential labor force; the same commuting times now apply to a larger geographic area and pool of potential workers.
- For goods movements, where even very minor travel time savings have direct consequences to the costs of shipping, businesses can increase the effective geographic reach of their markets.
- For seasonal visitors – an especially important segment of traveler for the Cape Cod economy – reduced travel allows more opportunities to spend time on shopping and other recreational activities, thereby enhancing the value of their experience on the Cape and possibly increasing visitor spending within the local economy.
- Finally, reduced travel times for non-work trips enhance the quality of life and personal satisfaction of residents, making Cape Cod a more desirable place to live and work, with consequent effects on property values and business location decisions.

Exhibit 4-41 presents the annual vehicle hour savings during weekday AM and PM peak periods (commuter travel periods) attributable to each demand model case compared to future (2040) no-build condition. The annual vehicle hour savings increases as additional transportation improvements are implemented, from 38,000 annual hours of savings for Case 1 to nearly 91,000 hours savings in Case 3A.

For the average daily commuter, the time saved annually could range from as much as 2 hours in Case 1 to over 4 hours in Case

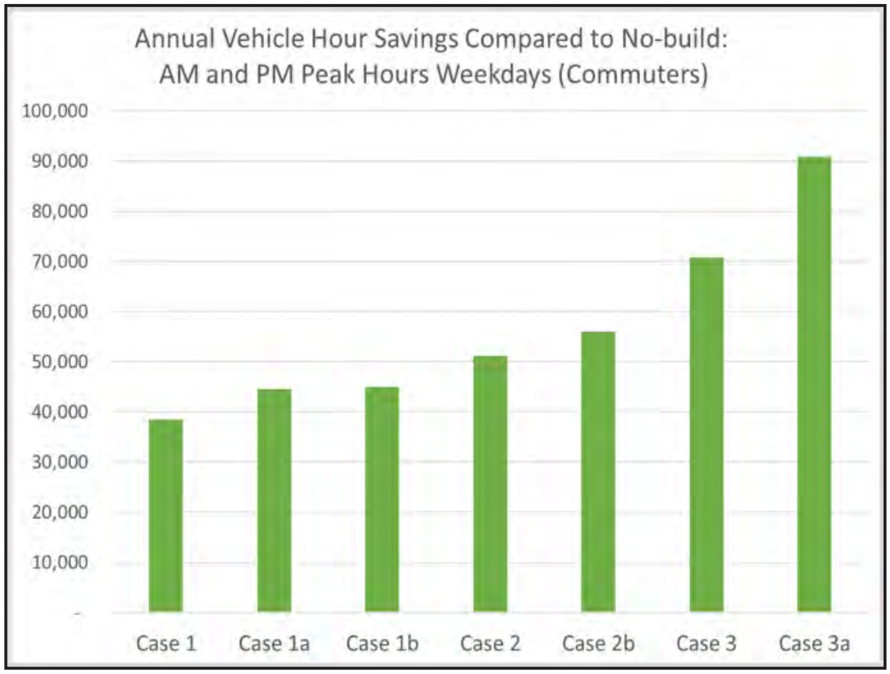



***Exhibit 4-41 Annual Vehicle Hours Savings (2040 Weekday AM/PM Peak Periods)***

3a. [3] As noted, these reductions in travel times can improve not only commuter satisfaction but also business productivity, including accessibility to a larger labor force, making the Cape more attractive for new businesses and investment to expand existing businesses.

Exhibit 4-42 presents annual vehicle hour savings compared to future no-build during summer weekend days, illustrating the relative merits of each case in facilitating seasonal visitations.[4] The annual vehicle hour savings increases during the summer weekend days as additional transportation improvements are implemented, from 150,000 annual hours of savings for Case 1 to 300,000 hours savings in Case 3A. Case 3A performs best in this comparison, reducing by almost 25% the delays otherwise experienced under no-build. Visitor spending can be boosted with less time (and expense) on the roads as well as the overall quality of their vacation experience. This can improve prospects for return visits as well as their personal and social media communications that might encourage others to visit.

Exhibit 4-43 presents annual vehicle hour savings compared to no-build for all trips, including the non-summer weekday PM and summer Saturdays peak hours, plus non-peak trips

3 There are approximately 21,400 daily commuters, 12,800 (60%) Cape to off-Cape and 8,600 (40%) off-Cape to Cape. On the roadway links for which travel times are measured for this study the improvements will save peak periods travelers between 4% (Case 1) and 9% (Case 3a) of the time they would otherwise spend under no-build in 2040.

4 Peak season weekend days, for the purposes of this analysis, are defined as the 30 weekend days and holidays between Memorial Day and Labor Day.

(therefore, the hours saved for the combination of the ‘summer Saturday’ and ‘AM and PM commute’ do not equal ‘all trips’ in Exhibit 4-43 because there are time periods included for ‘all trips’ calculation that are not included in either the non-summer weekday PM or summer Saturday peak periods).

The greater level of transportation investment in Cases 2B, 3, and 3A compared to the other alternatives leads to a greater reduction

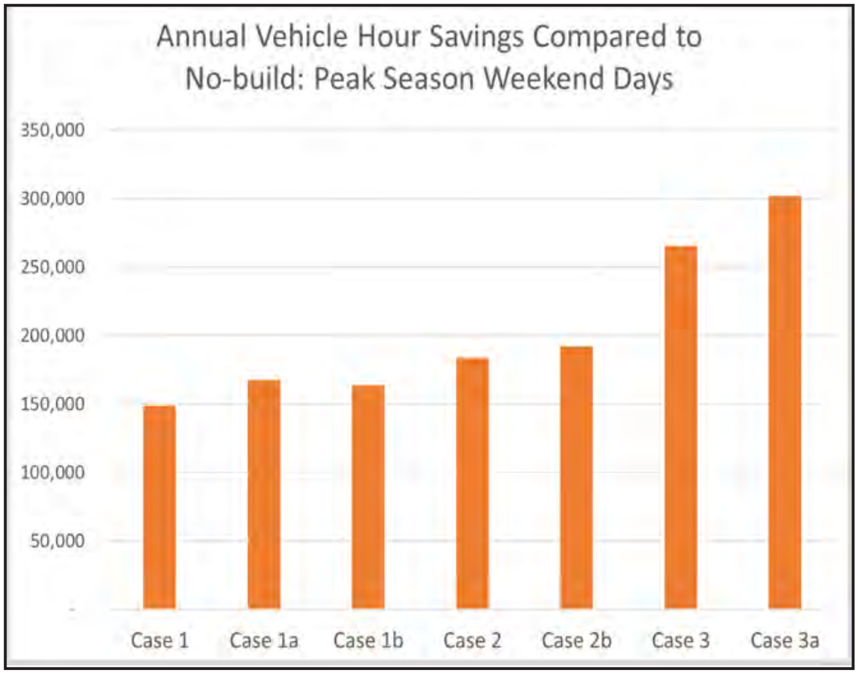
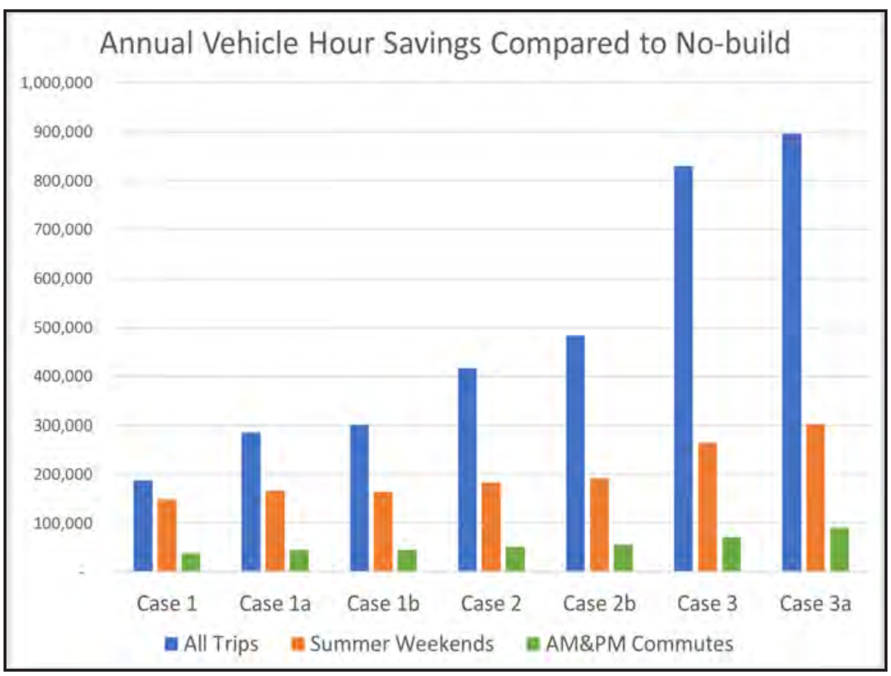



**Exhibit 4-42 Annual Vehicle Hours Savings (2040 Summer Saturday Peak Period)**

**Exhibit 4-43 Annual Vehicle Hour Savings (2040 All Trips)**



in travel times when all peak and non-peak trips are considered. For the aggregate annual vehicle hours traveled along the links analyzed in this study, the transportation improvements would save between 1% (Case 1) and 6% (Case 3A) in total travel time compared to the no-build condition in 2040.

As noted, these reductions in travel times can improve not only commuter satisfaction but also business productivity, including accessibility to a larger labor force, making the Cape more attractive for new businesses and investment to expand existing businesses.

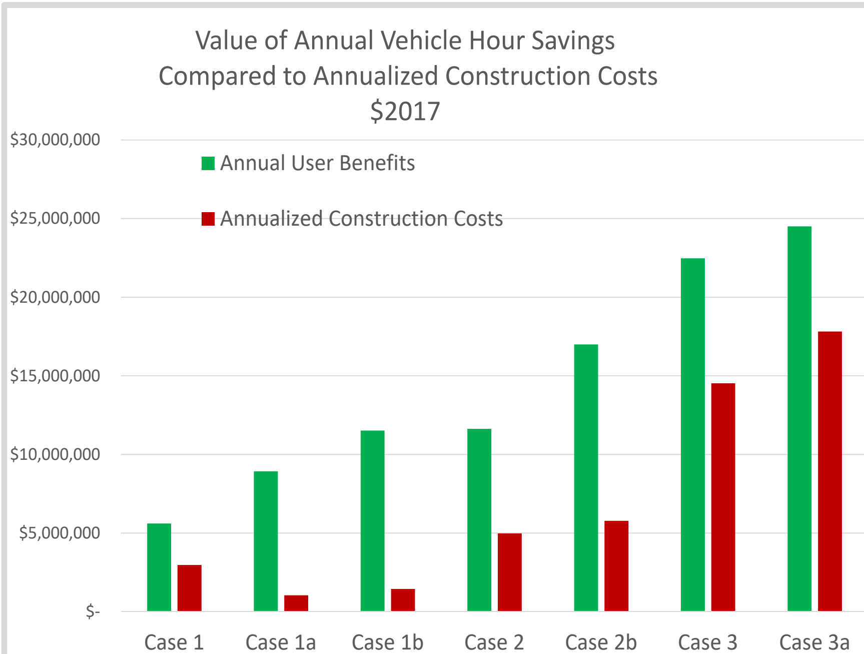
Travel time savings can be assigned per-hour dollar values and compared to annualized construction costs to measure the relative benefits of each alternative to users of the roadways[5]. This "User Benefit/Cost Analysis" is a tool commonly used by the Federal Highway Administration (FHWA) to evaluate funding applications for TIGER grants and other federal-aid projects. It is one measure of the relative merits of transportation projects but is not meant to substitute for the more inclusive evaluations conducted under state/federal environmental review under the Massachusetts Environmental Policy Act (MEPA) and the National Environmental Policy Act (NEPA). These reviews would include a broader analysis of potential environmental, social, and economic effect.

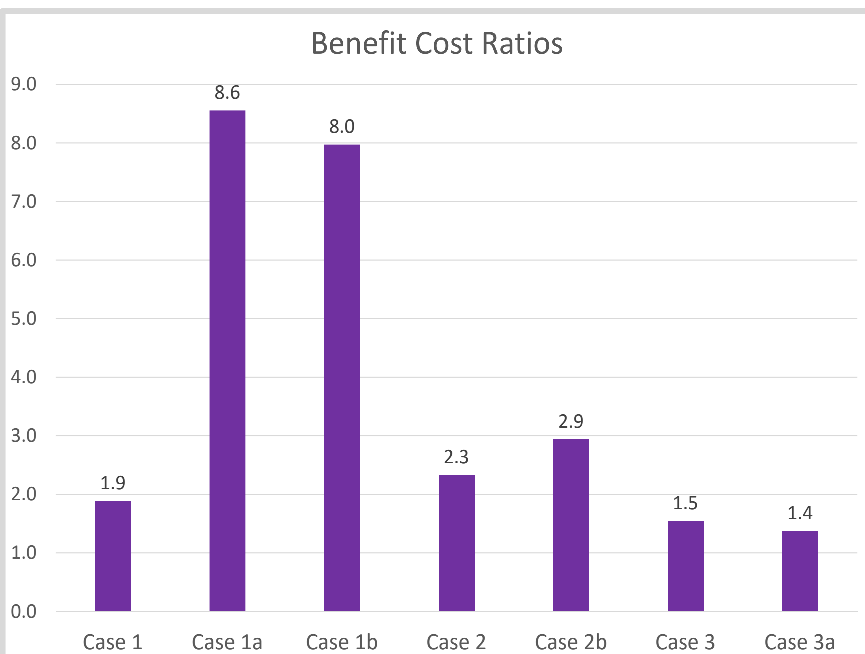
Exhibit 4-44 show the comparison of annual vehicle hour savings values to annualized construction costs. This exhibit demonstrates the favorable cost-benefit ratio of these improvements, ranging from 1.9:1 for Case 1, 7.9:1 for Case 1A, 2.3:1 for Case 2 and 1.4:1 for Case 3A. In each case, the value of travel time savings to users – which include commuters, other personal trips, peak weekends seasonal visitors, and truck trips – substantially exceed the annualized construction costs. The

5 The study team used dollar values for commuter, visitor, and non-business resident trips recommended in USDOT, Office of the Secretary of Transportation, Revised Guidance on Valuation of Travel Time in Economic Analysis, September 27, 2016 and adapted to local wage and income data provided by the Massachusetts Department of Labor & Workforce Development and the US Department of Commerce Bureau of Economic Analysis Regional Economic Information System (2016); and hourly value of freight estimates (assumed at 12% of total trips) from sources in the peer reviewed transportation literature, including Mahady & Lahr, Endogenous Regional Growth through Transportation Investment, National Academy of Sciences, Transportation Research Record, January 2009. Construction costs were estimated by Stantec (October 2018) and annualized over 20 years at a presumed 5% bond rate. Any and all of these analytic assumptions are subject to revision in subsequent project evaluations. The per hour dollar value of trip types used in this analysis are: commuters $32.41; seasonal visitors $19.04; other resident trips $16.20; trucks $90.

higher dollar value of user benefits shown in Cases 1A and 1B is a consequence of its relatively better performance in facilitating peak period commuter trips, which are valued higher than seasonal visitor and non-commuting resident trips[6].

***Exhibit 4-44 Annual Vehicle Hour Savings Compared to Annualized Costs***




6 The per hour dollar value of trip types used in this analysis (see above footnote for sources) are: commuters $32.41; seasonal visitors $19.04; other resident trips $16.20; trucks $90.

## 4.11 SUMMARY OF CONCEPTUAL COST ESTIMATES

Conceptual cost estimates were developed for each of the potential transportation improvements. Table 4-42 provides a summary of the conceptual cost estimates by location and Table 4-43 provides a summary of the conceptual cost estimate by case. More detailed conceptual cost estimates, including alternatives not selected for advancement, are provided in Appendix E. The methodology used to develop these costs is described in Section 4.2.2.

The cost estimate for potential roadway improvements and multimodal improvements are presented in Sections 4.4 and 4-11, respectively.

*Table 4-42 Summary of Conceptual Cost Estimate by Location*

| ALTERNATIVES | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Scenic Highway to Route 25 WB Ramp | $7 | $11 | $16 |
| Route 6 Exit 1C Relocation | $30 | $51 | $75 |
| Route 28 NB Ramp to Sandwich Road and Intersection Signalization | $6 | $11 | $16 |
| Bourne Rotary Reconstruction (3 signalized intersections)[1] | $11 | $18 | $26 |
| Belmont Circle Reconstruction | $14 | $23 | $33 |
| Route 6 Eastbound Travel Lane | $29 | $48 | $71 |
| Bourne Rotary Interchange[2] | $52 | $87 | $127 |
| Bourne Bridge Approaches[3] | $51 | $84 | $125 |
| Sagamore Bridge Approaches[3] | $39 | $64 | $95 |

*[1] Includes cost of Route 28 NB Ramp to Sandwich Road and Intersection Signalization.*
*[2] Includes cost of Bourne Rotary Reconstruction (Alternative 2)*
*[3] Includes approach roadway and bridge relocation and retaining walls*

*Table 4-43 Summary of Conceptual Cost Estimate by Case*

| CASE | 2017 | 2030 | 2040 |
|---|---|---|---|
| Case 1 | $37 | $62 | $91 |
| Case 1A | $13 | $22 | $32 |
| Case 1B | $18 | $29 | $42 |
| Case 2 | $62 | $103 | $150 |
| Case 2B | $72 | $121 | $177 |
| Case 3[1] | $181 | $299 | $441 |
| Case 3A[1] | $222 | $368 | $542 |

*[1] Includes highway approaches to Bourne and Sagamore Bridges. Does not include cost of replacement Bourne and Sagamore Bridges*

## 4.12 SUMMARY OF POTENTIAL ENVIRONMENTAL, COMMUNITY, AND PROPERTY IMPACTS

A summary of potential impact to environmental and community resources, and public and private property are provided below in Table 4-44 and Table 4-45 by location and by case, respectively. The boundaries of these resources are based on information from the MassGIS database or generated using publicly available information. Potential impact to these resources are based on the conceptual designs for transportation improvements developed and analyzed as part of the study process, and serve as a means to provide an order-of-magnitude understanding of the potential impact and provide a means to compare alternatives to one another.

*Table 4-44 Potential Environmental, Community, and Property Impact by Location*

| LOCATION | ENVIRONMENTAL (ACRES) | | | | COMMUNITY (ACRES) | | PROPERTY (ACRES) | | |
|---|---|---|---|---|---|---|---|---|---|
| | WETLAND | 100-YEAR FLOODPLAIN[1] | RARE SPECIES | WATER SUPPLY (ZONE I/II IWPA[2]) | OPEN SPACE | HISTORIC RESOURCES | RESIDENTIAL/ PUBLIC | COMMERCIAL | UTILITY |
| Route 6 Exit 1C Relocation | 0 | 0 | 7.2 | 5.7 | 0.6 | 0.2 | 0.2 | 0.9 | 3.8 |
| Scenic Hwy to Route 25 Ramp | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.9 |
| Belmont Circle (3 Leg Roundabout with Signalized Intersection) | 0.3 | 4.7 | 0 | 0.5 | 0.1 | 0 | <0.1 | <0.1 | 0 |
| Belmont Circle (Route 25 Eastbound Flyover) | 0.5 | 5.4 | 0 | 0.5 | 0.1 | 0 | <0.1 | <0.1 | 0 |
| Bourne Rotary (3 Signalized Intersections) | 0 | 0 | 0 | 0 | 0.4 | 0 | 0.4 | 0 | 0 |
| Bourne Rotary Interchange | 0 | 0 | 0.2 | 0 | 0.4 | 0 | 0.3 | 2.2 | 0 |
| Route 6 Eastbound - Additional Travel Lane | 0 | 0 | 3.9 | 0 | 0 | 0 | 0 | 0 | 0 |

[1] *Conceptual impact to 100-year floodplain calculated in acres.*
[2] *IWPA – Interim Well Protection Area*

Table 4-45 Potential Environmental, Community, and Property Impact by Case

| CASE (COMPONENTS OF EACH CASE LISTED ON TABLE 4-31) | ENVIRONMENTAL (ACRES) | | | | COMMUNITY (ACRES) | | PROPERTY (ACRES) | | |
|---|---|---|---|---|---|---|---|---|---|
| | WETLAND | 100-YEAR FLOODPLAIN[1] | RARE SPECIES | WATER SUPPLY (ZONE I/II IWPA[2]) | OPEN SPACE | HISTORIC RESOURCES | RESIDENTIAL/ PUBLIC | COMMERCIAL | UTILITY |
| Case 1 | 0 | 0 | 7.2 | 5.9 | 0.6 | 0.2 | 0.2 | 0.9 | 4.7 |
| Case 1A | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 0 | 0 | 0.9 |
| Case 1B | 0 | 0 | 0 | 0.2 | 0.4 | 0 | 0.4 | 0 | 0.9 |
| Case 2 | 0.3 | 4.7 | 7.2 | 6.4 | 1.1 | 0.2 | 0.6 | 0.9 | 4.7 |
| Case 2B | 0.5 | 5.4 | 7.2 | 6.4 | 1.1 | 0.2 | 0.6 | 0.9 | 4.7 |
| Case 3 | 0.3 | 4.7 | 11.1 | 6.4 | 1.1 | 0.2 | 0.6 | 0.9 | 4.7 |
| Case 3B | 0.3 | 4.7 | 11.3 | 6.4 | 1.1 | 0.2 | 0.5 | 3.1 | 4.7 |

[1] *Conceptual impact to 100-year floodplain calculated in acres.*
[2] *IWPA – Interim Well Protection Area*

## 4.13 MULTIMODAL IMPROVEMENTS

Improvements to multimodal transportation facilities in the study area were evaluated, including improvements to pedestrian, bicycle, transit, bus, and park-and-ride facilities. This evaluation considered improvements to existing facilities, new connections between existing facilities, and construction of new facilities. The existing multimodal transportation facilities in the study area are described in Section 2.6.

### 4.13.1 Bicycle/Pedestrian Facility Improvements

There are several high-quality bicycle/pedestrian facilities in the study area including the seven-mile long service roads (bike paths) along the north and south side of the Cape Cod Canal and the 10.6-mile long Shining Sea Bike Path in Falmouth. Route 6A in the study area is a designated bike route (Exhibit 2-45).

Currently ongoing improvements to bicycle/pedestrian facilities in the study area include the development of a shared-use path adjacent to the Service Road in Sandwich (a state project scheduled for 2022 construction) and the reconstruction and widening of portions of the Shining Sea Bikeway in Falmouth (municipal project, scheduled for 2020 construction).

The Cape Cod Commission completed a feasibility study in 2017 of the Bourne Rail Trail – a bike trail that would connect the north end of the Shining Sea bikeway to the Cape Cod Canal bike path. There is strong local support for this trail from state senators and representatives, the boards of selectman in Bourne, Falmouth, and Sandwich, and the ‘Friends of the Bourne Rail Trail’ advocacy group.


***Exhibit 4-45 New Bicycle/Pedestrians Connections to Cape Cod Canal Bike Trail***

## *Bicycle/Pedestrian Improvements*

The following section presents potential improvements to bicycle and pedestrian facilities in the study area.

### *Improved Bicycle/Pedestrian Connections to Canal Service Roads*

While there are several accessible connections to the Canal service roads (bike paths) from the local roadway network or parking lots, there are also notable areas that lack an accessible, ADA-compliant connection to the service road. Access and use of the  Canal service road by all users could be improved through the construction of new accessible connections to the service road from the local roadway network.

Gaps in the accessible connections to the Canal service road were identified both north and south of the Canal. Three potential locations were identified to provide access to the service road from local roads, including new connections from Pleasant Street and the Bourne Ball Field, (south of the Canal in Bourne) and at Old Bridge Road on the north side of the Canal in Bourne (Exhibit 4-45).

**Pleasant Street, Bourne**

Location: Pleasant Street in Bourne is south of the Canal and east of the Sagamore Bridge. The new connector path to the service road would be to the west of 39 Pleasant Street.

Challenges: While this new connection to the Canal service road would not impact any regulated environmental resources, it would require a minor acquisition of private property and close coordination with the USACE (owner of the Canal service road) and the MBTA to allow a crossing of the Cape Cod Rail Line adjacent to the Canal service road.

Conceptual Cost Estimate: $25,000 (2017 costs)

**Bourne Ball Field, Bourne**

Location: The Bourne Ball Field is located at 861 Sandwich Road in Bourne. The Ball Field is south of the Canal, east of the Sagamore Bridge. An informal 125-foot long path currently exists, which extends from Pleasant Street, crossing the Canal rail line, to the Canal service road.

Challenges: While this new connection to the Canal service road would not impact any regulated environmental resources, it would require close coordination with the USACE and the MBTA to allow a crossing of the Cape Cod Rail Line adjacent to the Canal service road.

Conceptual Cost Estimate: $50,000 (2017 costs)

**Old Bridge Road, Bourne**

Location: Old Bridge Road is accessed from Main Street in Bourne, north of the Canal and west of the Bourne Bridge. An informal 125-foot long path currently exists, which extends from Pleasant Street, crossing the Canal rail line, to the Canal service road.

Challenges: This new connection to the Canal service road would require the filing of a Notice of Intent with the Bourne Conservation Commission, as it is within the 100-year floodplain of the Canal. It would require close coordination with the USACE to allow access to the Canal service road.

Conceptual Cost Estimate: $20,000 (2017 costs)

*Improved Bicycle/Pedestrian Access to and Across the Cape Cod Canal*

Residents and visitors in the study area would benefit from improved bicycle/pedestrian facilities crossing the Canal on the Sagamore and Bourne bridges. The existing Canal bridges each have five-foot wide sidewalks on one side of the bridge but

generally lack suitable sidewalk connections between the bridges, the local roadway system, and the Canal bike path. As the travel lanes on the bridges lack roadway shoulders, vehicles travel right next to the existing sidewalk. The proximity of vehicles to pedestrians on the bridge sidewalk creates discomfort for some pedestrians, discouraging sidewalk use. Viewing platforms and benches for pedestrians are also lacking along the bridges' approximately 2,000-foot length. The lack of roadway shoulders also results in the bridges being unsuitable for bicycle travel.

Several potential locations to improve bicycle/pedestrian travel across the Canal were evaluated. While the facilities on the bridges themselves cannot be updated at this time, the sidewalks that approach the bridges could be widened and reconstructed to meet ADA-compliance. Further, gaps in the sidewalk network could be completed to allow for an uninterrupted sidewalk access across the Canal to the local roadway network or the Canal bike path. Specific improvements at the Sagamore and Bourne Bridges are described below.

**Location: Sagamore Bridge Area (Exhibit 4-46)**

North of the Sagamore Bridge: reconstruct and widen existing 800-foot sidewalk from Canal Road (at the Sagamore Park and Ride lot) to the north side of the Sagamore Bridge.

South of the Sagamore Bridge: Construct 1,000 feet of new ADA-compliant sidewalk adjacent to the east side Route 6 and Cranberry Highway from the south end of the existing sidewalk to Adams Street. To provide a connection to Sandwich Road, construct a shared-use path along Adams Street. Since Adams was converted in 2015 to one-way (south) travel only, additional paved space exists for use as a shared-use path. From the north end of Adams Street (at Sandwich Road), an additional crosswalk connection could be made to the Canal Bike Path using the Bourne Ball Field connector.

Conceptual Cost Estimate:  $3.9 million (2017 costs)

**Location: Bourne Bridge Area (Exhibit 4-47)**

North of the Bourne Bridge: Construct a 1,200-foot-long ADA-compliant sidewalk from the east side of Belmont Circle (shopping plaza entrance drive) to the north side of the Bourne Bridge.

Conceptual Cost Estimate: $800,000 (2017 costs)

South of the Bourne Bridge: A bicycle/pedestrian improvement project was completed by MassDOT during the summer of 2017, when MassDOT constructed a 750-foot long extension of the

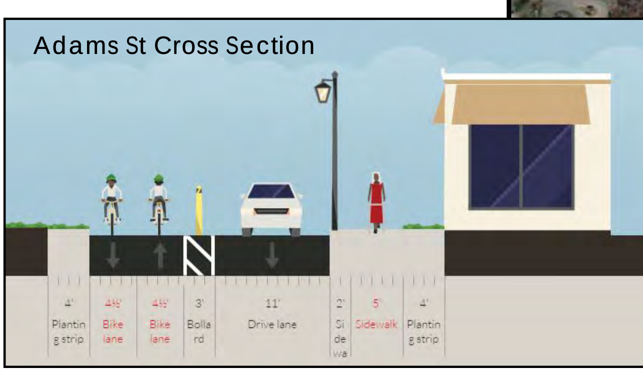
*Text continues on page 4-120.*

**Exhibit 4-46** **Bicycle/Pedestrian Connections at Sagamore Bridge**

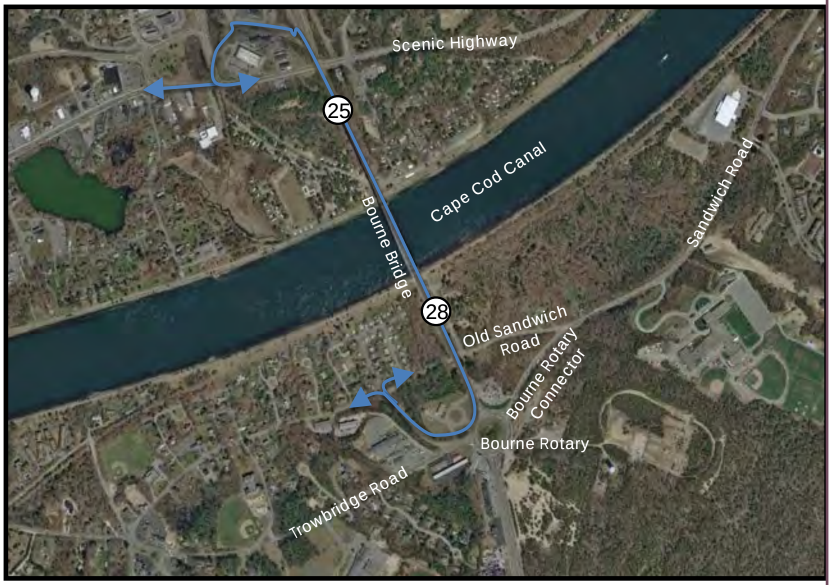
Desired Bicycle/Pedestrian Access over Sagamore Bridge


Bicycle/Pedestrian Access over Sagamore Bridge (North of Canal)


Bicycle/Pedestrian Access over Sagamore Bridge (South of Canal)

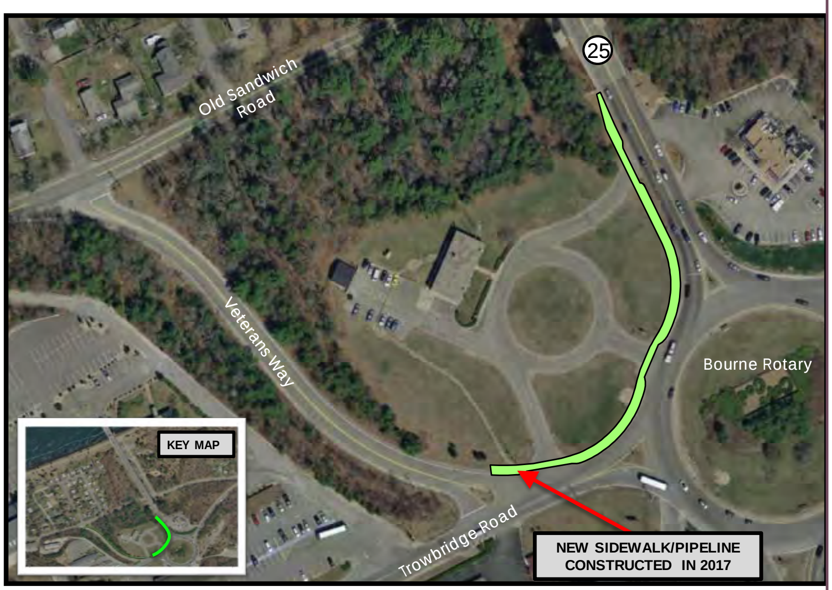



Desired Bicycle/Pedestrian Access over Bourne Bridge




Bicycle/Pedestrian Access over Bourne Bridge (North of Canal)


Bicycle/Pedestrian Access over Bourne Bridge (South of Canal)



sidewalk on the south side of the Bourne Bridge. This 10-foot wide sidewalk wraps around the state police barracks property to the intersection of Veterans Way and Trowbridge Road.

*Improved Bicycle/Pedestrian Accommodation along Bus Routes*

Multimodal travel in the study area could be enhanced through improvements in bicycle and pedestrian facilities along bus routes. This is an important part of an overall effort towards creating an integrated multimodal transportation system.

Several key bus routes in the study area, including those along County Road and Route 151 along the Bourne Run bus line and Route 6A, Route 130, Service Road, and Quaker Meeting House Road along the Sandwich Line. The roadways along these bus routes lack consistent ADA-compliant sidewalks, roadway shoulders suitable for bicycle travel, bus shelters, and bike racks.

### 4.13.2 Multimodal Transportation Center

Multimodal centers provide commuters and other travelers with free and secure parking when transferring to carpool or transit services. These centers are beneficial for reducing the cost of daily commutes and reducing traffic volumes by limiting single-occupant vehicle travel. A transportation center, such as the Hyannis Transportation Center, generally provides vehicle parking, bike racks, indoor areas to purchase transit tickets, public bathrooms, visitor information, and vending. A simpler transportation center (a Park & Ride lot) typically provides parking and a bus shelter.

**A new Park & Ride lot at Route 6 Exit 2 (Route 130) would reduce traffic volumes by providing additional commuter parking.**

As noted in Section 2.6.9, there are two Park & Ride lots along the Route 3/Route 6 corridor, including the 377-space Sagamore lot located north of the Cape Cod Canal at Route 3 Exit 1A (the Route 3/Route 6 [Scenic Highway]) interchange in Bourne and the 365-space lot at Route 6 Exit 6 in Barnstable. These lots are serviced by the Plymouth & Brockton (P&B) Bus Company, which operates daily bus routes from Hyannis to Boston. Local bus connections to the Park & Ride lots are provided by the Cape Cod Regional Transit Authority (CCRTA).

These lots are heavily used by commuters and are often at or near capacity. A mid-week occupancy count, conducted at the Sagamore lot in October 2016, found the lot was 99% occupied.

The feasibility of constructing an additional Park & Ride lot along Route 6 between the existing lots at Exit 1A in Bourne and Exit 6 in Barnstable was evaluated.

A new lot at Exit 2 (Route 130) was determined feasible because MassDOT owns sufficient land at the southwest quadrant of the

interchange, there are no wetland resources present, and the P&B bus line and CCRTA Sandwich line already pass by this location. Furthermore, the western terminus of the upcoming Service Road shared-use path is Route 130 at this location. The hilly topography of this parcel may initially limit the size of the lot to approximately 100 cars, but a larger lot could be constructed with additional site grading (Exhibit 4-48).

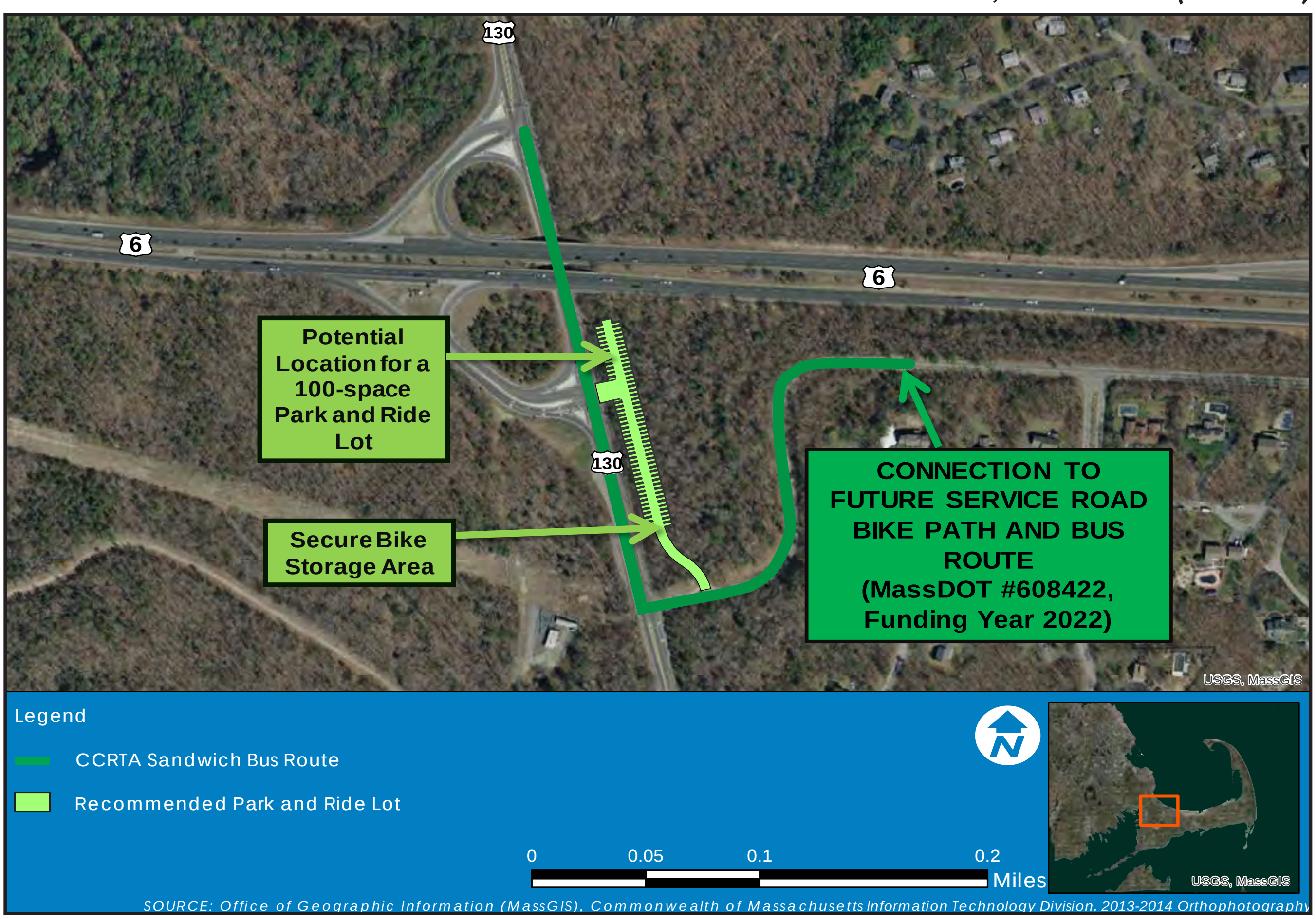
### *Conceptual Cost Estimate*

The conceptual cost for the Park & Ride lot at Route 6 Exit 2 is provided in Table 4-46, by construction year. More detailed conceptual cost estimates are provided in Appendix E.

*Table 4-46 Route 6 Exit 2 Park and Ride Lot - Conceptual Cost Estimate by Build Year*

| | 2017 ($ MILLION) | 2030 ($ MILLION) | 2040 ($ MILLION) |
|---|---|---|---|
| Park and Ride Lot | 2.8 | 4.6 | 6.8 |

***Exhibit 4-48 Park & Ride Lot, Route 6 Exit 2 (Route 130)***




massDOT
Massachusetts Department of Transportation



# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# CONTENTS



# EXHIBITS



# TABLES




# Study Recommendations

The recommendations for the Cape Cod Canal Transportation Study are based on the ability of the potential transportation improvement alternatives to meet the study's goals and objectives. As defined in Chapter 1, the goals and objectives of this study are:

**Goals**

- Improve transportation mobility and accessibility in the Cape Cod Canal area and provide reliable year-round connectivity over the Canal and between the Sagamore and Bourne Bridges.

**Objectives**

- Improve multimodal connectivity and mobility across the Canal to avoid degrading quality of life on the Cape.
- Ensure that cross-Canal connectivity does not become a barrier to reliable intra community travel within Bourne and Sandwich.
- Create a reliable multimodal connection across the Canal to assure public safety in the event of an emergency

evacuation of portions of the Cape and accommodate first responders trying to reach the Cape.

The alternatives that best met these goals and objectives were determined through a combination of analytical methods and an extensive public participation process.

## 5.1 EVALUATION CRITERIA

Alternatives were compared to the future no-build transportation conditions on their ability to meet the evaluation criteria established with input from the Working Group at the onset of the study (Chapter 1, Table 1-1). These evaluation criteria were developed with the aim of advancing the study's goals and objectives and consist of various measures of an alternative's impact on the following categories:

- transportation
- safety
- environmental and community resources
- economic development

Review of an alternative's performance compared to the future no-build condition provides an opportunity to gain a complete understanding of an alternative's potential benefits and impacts prior to making study recommendations.

## 5.2 EVALUATION METHODOLOGY

The recommendations for roadway improvements are based on the effectiveness and potential benefits and/or impacts of the various suite of improvements evaluated under the travel analysis model cases. A matrix was developed to compare each of the travel analysis model cases against the future no-build conditions. This evaluation matrix characterizes the transportation performance or potential environmental or property impact category based on either quantifiable data (using existing data or data produced for this study) or subjective qualitative measures.

The matrix uses different symbols to indicate minor, moderate, or substantial benefits or impact. If no impact or benefit is anticipated (or an environmental resource is not present) a neutral symbol is used. The specific definitions used to

differentiate minor, moderate, or substantial impact to environmental resources are provided in Exhibit 5-1.

The complete Evaluation Matrix is provided in Exhibit 5-2. Ultimately, review of the completed evaluation matrix and consultation with the Working Group and the public, aided MassDOT's decision-making process to identify which Case to recommend for advancement into MassDOT's project development process.

***Exhibit 5-1 Alternatives Evaluation Matrix – Definition of Benefit and Impact Ratings***

| Alternatives Evaluation Matrix Legend | | | | |
|---|---|---|---|---|
| **Category** | **Benefit Levels** | | | |
| | ◇ | ○ | ◒ | ● |
| **Safety (Emergency Vehicle Response Time)**<br>**Bicycle/Pedestrian (facilities or access)** | **Neutral** | **Minor or No Impact** | **Modest Benefit** | **Substantial Benefit** |
| | **Impact Levels** | | | |
| | ◇ | ○ | ◒ | ● |
| | **Neutral (No impact or resource not present)** | **Minor or No Impact** | **Modest Impact** | **Substantial Impact** |
| **Wetlands** | | | 5,000 SF - 1 acre of wetlands | > 1 acre of wetlands |
| **Rare Species** | | | > 1 acre of work in rare species habitat | Requires a Conservation Management Permit |
| **Area of Critical Environmental Concern (ACEC)** | | | Impacts land within ACEC | Impacts wetlands within ACEC |
| **100-Year Floodplain** | | | Moderate fill within 100-year floodplain | Substantial fill within 100-year floodplain |
| **Water Supply Protection Areas** | | | Impact to land in DEP IWPA or Zone II | Impact to land in DEP Zone I or ORW |
| **Air Quality/Public Health** | | | Modest reductions in idle time/queueing | Substantial reductions in idle time/queueing |
| **Open Space** | | | Acquisition of open space land | Acquisition of open space affecting or active recreational facilities |
| **Historic Resources** | | | Impacts historic parcel or historic district | Adverse Effect on historic property |
| **Land Use/Economic Development** | | | Modest impact to residential, commercial, or utility-owned property | Substantial impact to residential, commercial, or utility-owned property |

***Exhibit 5-2 Evaluation Matrix – Comparison of Travel Analysis Model Cases***

| Category | | | 2040 Future No-Build | | Case 1 | | Case 1A | | Case 1B | | Case 2 | | Case 2B | | Case 3 | | Case 3A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rating | Data | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) | Rating | Data / % Change from 2040 No-Build (000's) |
| Traffic | Vehicle Hours Traveled | Annual | ◇ | 16.3 mil | ○ | 530 | ○ | 659 | ◒ | 860 | ◒ | 1,070 | ◒ | 1,290 | ● | 1,306 | ● | 1,390 |
| Traffic | Average Delay at BC & BR (mins) | Summer Sat | ◇ | 6.8 | ○ | 6.5 | ◒ | 5.4 | ◒ | 5.1 | ◒ | 4.3 | ○ | 6.7 | ◒ | 7.9 | ● | 3.7 |
| Traffic | Average Delay at BC & BR (mins) | Fall PM | ◇ | 3.4 | ◒ | 2.5 | ◒ | 2.6 | ● | 1.0 | ● | 0.6 | ● | 0.4 | ● | 0.5 | ● | 0.2 |
| **Category** | | | | | | | | | | | | | | | | | | |
| **Safety / Emergency Response Time** | | | | | ○ | | ○ | | ◒ | | ◒ | | ◒ | | ◒ | | ● | |
| **Bike / Ped (Safety and New Facilities)** | | | | | ◇ | | ○ | | ◒ | | ◒ | | ◒ | | ● | | ● | |
| Environmental | Wetlands (acres) | | | | ○ | 0.0 | ○ | 0.0 | ○ | 0.0 | ◒ | 0.3 | ◒ | 0.5 | ◒ | 0.3 | ◒ | 0.3 |
| Environmental | Rare Species (acres) | | | | ● | 7.2 | ◇ | 0.0 | ◇ | 0.0 | ● | 7.2 | ● | 7.2 | ● | 11.1 | ● | 11.3 |
| Environmental | 100-yr Floodplain (acres) | | | | ◇ | 0.0 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 4.7 | ◒ | 5.4 | ◒ | 4.7 | ◒ | 4.7 |
| Environmental | Water Supply (Zone I/II,IWPA) (acres) | | | | ◒ | 5.9 | ○ | 0.2 | ◇ | 0.0 | ◒ | 6.4 | ◒ | 6.4 | ◒ | 6.4 | ◒ | 6.4 |
| Community | Open Space (acres) | | | | ◒ | 0.6 | ○ | 0.2 | ○ | 0.2 | ◒ | 1.1 | ◒ | 1.1 | ◒ | 1.1 | ◒ | 1.1 |
| Community | Historic Resources (acres) | | | | ◒ | 0.2 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 0.2 | ◒ | 0.2 | ◒ | 0.2 | ◒ | 0.2 |
| Property Impacts | Residential (acres) | | | | ○ | 0.2 | ◇ | 0.0 | ◇ | 0.0 | ○ | 0.5 | ○ | 0.6 | ○ | 0.6 | ○ | 0.5 |
| Property Impacts | Commercial (acres) | | | | ◒ | 0.9 | ◇ | 0.0 | ◇ | 0.0 | ◒ | 0.9 | ◇ | 0.0 | ◒ | 0.9 | ◒ | 0.9 |
| Property Impacts | Utility (acres) | | | | ● | 4.7 | ◒ | 0.9 | ◒ | 0.9 | ● | 4.7 | ● | 4.7 | ● | 4.7 | ● | 4.7 |
| Economic Impact | | | | | ◒ | | ◒ | | ◒ | | ● | | ◒ | | ● | | ● | |
| **2030 Cost ($ millions)** | | | | | | **60** | | **20** | | **30** | | **100** | | **120** | | **300** | | **370** |

## 5.3 MULTIMODAL TRANSPORTATION IMPROVEMENT RECOMMENDATIONS

Multimodal transportation improvements were recommended for study area bicycling and pedestrian facilities, multimodal facilities, and roadways. The following sections describe these recommendations.

### 5.3.1 Bicycle and Pedestrian Improvements

**Recommendation:** Improve and expand bicycle and pedestrian facilities in the study area to encourage greater use of non-motorized transportation by residents and visitors.

The specific bicycle and pedestrian improvements recommended include the three categories of improvements listed below. These recommended improvements are described more fully in Section 4.13.1.

1. **New ADA-compliant pedestrian connections to the Cape Cod Canal Bikeway at three locations (Exhibit 4-45):**
   - Bourne Ballfield, Bourne;
   - Pleasant Street, Bourne; and
   - Old Bridge Road, Bourne.
2. **Improve bicycle and pedestrian connections to/from local roadways over the Canal at both the Sagamore and Bourne Bridges (Exhibit 4-46 and 4-47).**
3. **Improve bicycle/pedestrian accommodation along roadways in the study area, especially along bus routes, by providing:**
   - Accessible sidewalks and crosswalks;
   - Pedestrian signal phases at intersections;
   - Shelters at bus stops;
   - Bicycle racks;
   - Wayfinding signage; and
   - Bicycle accommodations in roadway shoulders.

These improvements could be stand-alone improvements or incorporated into a roadway improvement project.

**Benefit:** Improved and expanded bicycle and pedestrian facilities would encourage non-motorized travel and enhance recreational opportunities for residents and visitors. These improvements would advance the study goal of creating and improving multimodal mobility in the Cape Cod Canal area.

### 5.3.2 Multimodal Improvements

**Recommendation:** Develop a new Multimodal Transportation Center (with 100-space park and ride lot) at the Route 6 Exit 2 (Route 130) interchange.

**Benefit:** Additional park and ride facilities will encourage more travelers to use bus service and reduce single-occupant car travel. These improvements would advance the study goal of creating and improving multimodal mobility in the Cape Cod Canal area.

The location of a park and ride lot at the Route 6 Exit 2 (Route 130) interchange is desirable since it is owned by MassDOT and does not contain any regulated environmental resources. Additionally, the western terminus of the planned Service Road shared-use path is at this location.

## 5.4 ROADWAY IMPROVEMENTS

Recommendations for improvements to the study area roadway system were selected based on the travel model analysis and potential impact to environmental and community resources and public and private property. The recommendations are presented in two groups:

- Local intersection improvements, and
- Gateway intersection improvements (larger improvements).

The project development period for these projects will vary based on project complexity. Larger, more complex projects require a longer period to complete the design, environmental review and permitting, and (if required) land acquisition processes. For example, new highway ramps could require extensive coordination with local utility providers to ensure uninterrupted service and safety during the relocation of their equipment (if necessary).

To enhance multimodal accessibility, MassDOT will evaluate improvements to pedestrian, bicycle and transit facilities at each location. For pedestrians, these improvements may include accessible sidewalks, crosswalks, and signal systems. Bicycle improvements include separated bicycle lanes, marked bicycle lanes on roadway shoulders, and accessible connections to regional bicycle paths. These pedestrians and bicycle facility improvements enhance access to transit facilities.

As appropriate, transportation system design will incorporate Intelligent Transportation System (ITS) improvements to provide real-time traveler information, weather conditions, work-zone management, and emergency management information.

Close coordination between MassDOT and USACE will continue regarding the rehabilitation or replacement of the Canal Bridges and (as necessary) the relocation of the roadway and bridge approaches to these bridges.

### 5.4.1 Local Intersection Improvements

**Recommendation:** The recommended local intersection improvements include advancing several intersection improvement projects into the project development phase. As described in Section 4.4 and shown on Exhibits 5-3 and 5-4, these intersection improvements include the following potential transportation projects:

Signal timing improvements at two intersections:

1. **Scenic Hwy/Meeting House Lane at State Road/Canal Road; and**
2. **Scenic Highway at Nightingale Road.**

Intersection Improvements at three intersections

1. **Route 6A (Sandwich Road) at Cranberry Hwy;**
2. **Route 130 at Cotuit Road; and**
3. **Sandwich Road at Bourne Rotary Connector.**

***Exhibit 5-3 Recommended Local Intersection Equipment Improvements***

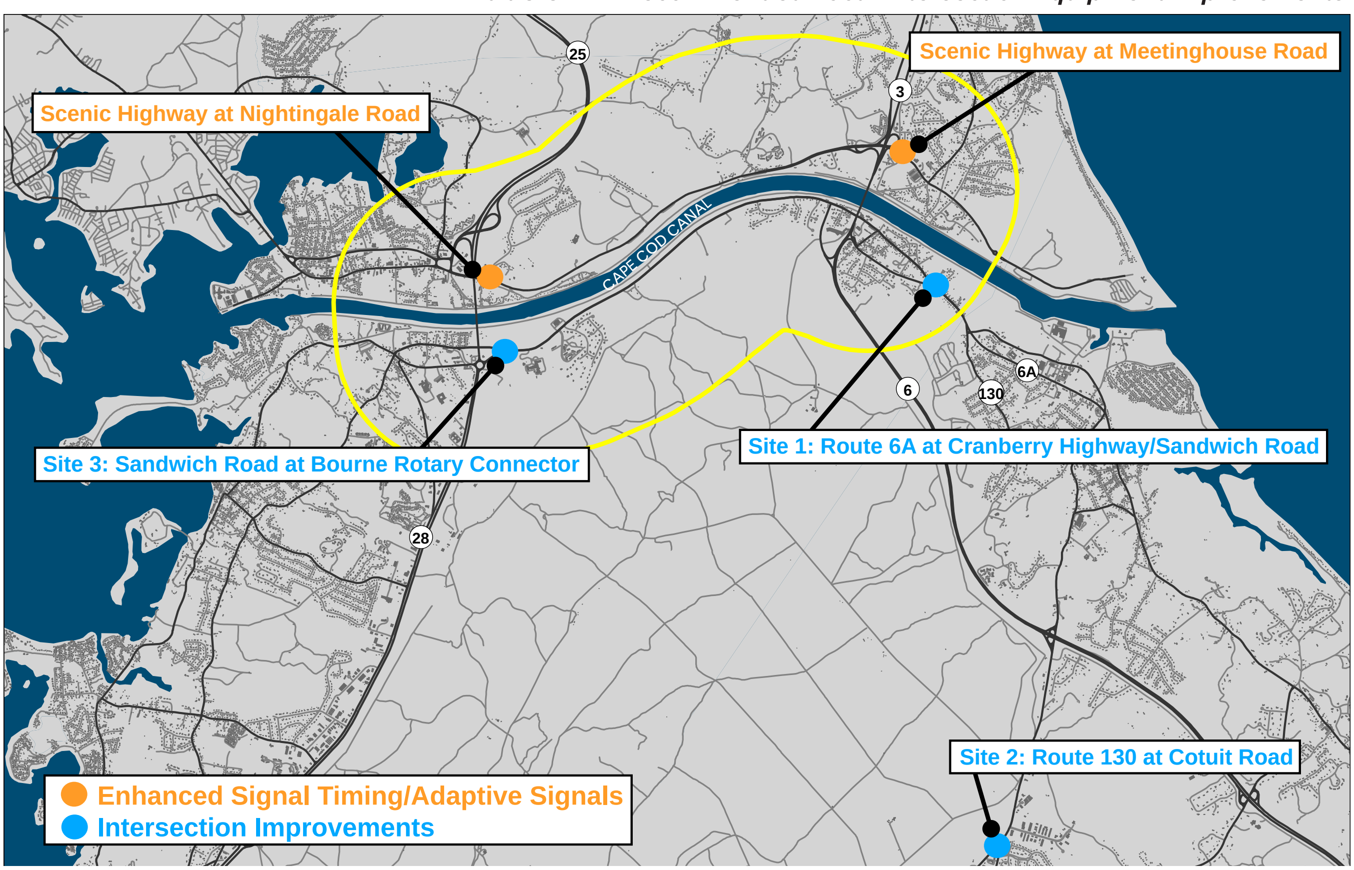


**Exhibit 5-4** ***Recommended Local Intersection Reconstructions***

<u>Site 1</u>
Route 6A (Sandwich Road) at Cranberry Highway


<u>Site 2</u>
Route 130 at Cotuit Road


<u>Site 3</u>
Sandwich Road & Bourne Rotary Connector

**Benefit:** These intersection roadway improvements represent a lower-cost method to reduce congestion and improve safety at key study area intersections. These improvements would advance the study goal of improving transportation mobility and accessibility in the Cape Cod Canal area.

### 5.4.2 Gateway Intersection Improvements

For each of the Travel Analysis Model Cases, the study team evaluated the results of the traffic analysis and the potential benefit or impact on the various evaluation criteria categories, as shown on the evaluation matrix (Exhibit 5-2).

In coordination with the Working Group, the components of Case 3A were identified as the transportation improvements that would most effectively satisfy the study's goals and objectives.

As described in Section 4.9 and shown on Exhibit 5-5, Case 3A includes the following improvements:

*Table 5-1 Components of Case 3A - Recommended Gateway Intersection Improvements*

| LOCATION ON EXHIBIT 5-5 | RECOMMENDED GATEWAY INTERSECTION IMPROVEMENT |
|---|---|
| A | Scenic Highway to Route 25 Westbound Ramp |
| B | Bourne Rotary Interchange |
| C | Belmont Circle Reconstruction |
| D | Route 6 – Relocation of Exit 1C |
| E | Route 6 – Additional Travel Lane to Exit 2 (Route 130) |
| F | Reconstruction of Sagamore Bridge Approaches |
| G | Reconstruction of Bourne Bridge Approaches |
| H | Replacement of Bourne and Sagamore Bridges (By USACE) |

Case 3A was identified as the recommended set of transportation improvements because they would most effectively satisfy the study goals and objectives. Case 3A would:

- Provide the greatest long-term improvement in accessibility and mobility for Cape Cod residents, employers, and visitors;
- Provide a reliable multimodal transportation system to assure public safety in the event of an emergency evacuation of Cape Cod;
- Focus on improving existing infrastructure, thereby minimizing potential property takings and impact to natural and social environmental resources; and
- Accommodate the rehabilitation or replacement of the Canal bridges, envisioned as having two travel lanes and one auxiliary lane in each direction.

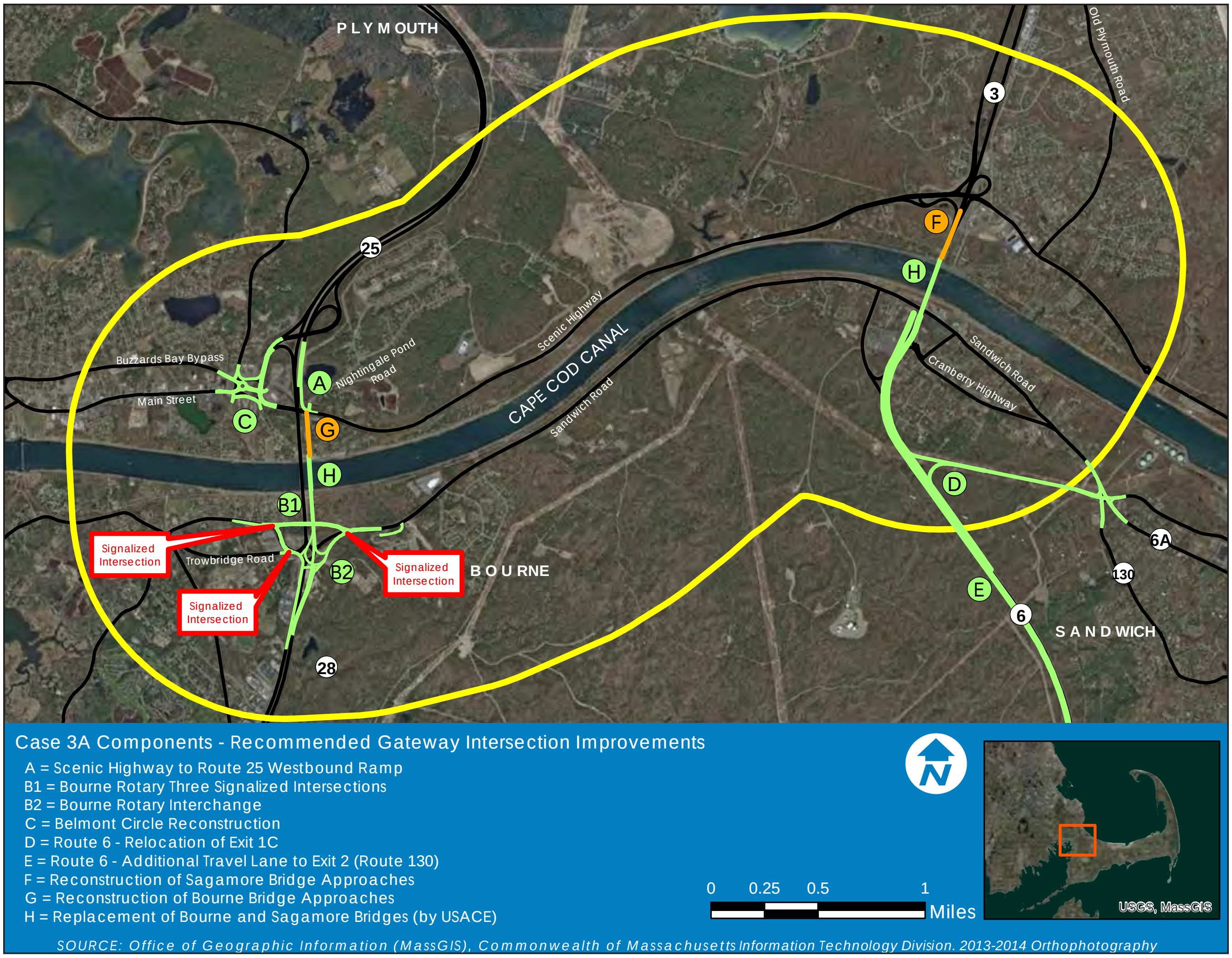



***Exhibit 5-5 Components of Case 3A - Recommended Gateway Intersection Improvements***

### *Potential Case 3A Stages:*

The Case 3A improvements could be advanced as a single project or, as described below, through a series of up to four project stages. These potential stages could be combined into fewer stages or completed in different combinations of improvements. However, the benefits to advancing the Case 3A improvements in stages include:

- Lower financial commitment during any single construction period;
- Reduced community disruption;
- Independent benefit will be provided for each project stage;

- Benefits to transportation system increase as each successive stage is implemented;
- Each stage is compatible with other stages, resulting in no wasted transportation dollars;
- If desired, portions of certain stages could be combined.

Below is a description of four potential Case 3A stages.

*Stage 1*

1. **Scenic Highway to Route 25 westbound on-ramp (Component A on Exhibit 5-5)**
2. **Bourne Rotary – Three Signalized Intersections (Component B-1 on Exhibit 5-5)**

*Benefit of Stage 1:* Implementation of the Stage 1 improvements would substantially reduce delays at Both Belmont Circle and Bourne Rotary, especially during the non-summer weekday peak periods.

*Challenges of Stage 1:* Construction of a new highway on-ramp from Scenic Highway to Route 25 westbound would require the use of land containing natural gas lines, requiring close coordination with the utility provider and potential relocation of the gas lines. At Bourne Rotary, close coordination would be required to accommodate the relocation of the Technical High School driveway and for work adjacent to the state police barracks.

*Stage 2*

1. **Belmont Circle – Three-Leg Roundabout with Signalized Intersection (Component C on Exhibit 5 5)**

*Benefit of Stage 2:* This would further reduce delay at Belmont Circle and Bourne Rotary, especially during non-summer peak periods. Improvements to bicycle and pedestrian accommodations would improve access between the businesses and residential areas west of Belmont Circle in Bourne and Scenic Highway, the Canal bike trail, and the Bourne Scenic Park Campground.

*Challenges of Stage 2:* The reconstruction of Belmont Circle would impact regulated wetlands and floodplain, requiring the filing of a Notice of Intent with the Bourne Conservation Commission and appropriate wetlands avoidance and mitigation. Maintaining access to local business during construction would also be a priority.

*Stage 3*

1. **Relocation of Route 6 Exit 1C (Component D on Exhibit 5-5)**

2. **Route 6 – Additional Eastbound Travel Lane to Exit 2 (Route 130) (Component E on Exhibit 5-5)**

Unlike Stages 1 and 2, Stage 3 is not interrelated with the other Case 3A improvements and could be built at any time and improve traffic conditions. The full benefit of these improvements would be realized with a replacement Canal bridge in place. It is assumed that the relocation of Exit 1C will be required when the Sagamore Bridge is replaced.

*Benefit of Stage 3:* Would reduce delay on Route 6 westbound during both summer and non-summer peak periods. Delays are substantially reduced on Route 3 southbound when these improvements are combined with the replacement of the Sagamore Bridge.

*Challenges of Stage 3:* The relocation of Exit 1C and the additional eastbound travel lane on Route 6 would result in approximately 7.2 acres and 3.9 acres of disturbance to rare species habitat, respectively. These projects would require close coordination with the Massachusetts Natural Heritage and Endangered Species Program, including the preparation of a Conservation Management Permit with appropriate impact mitigation.

The relocation of Exit 1C would also require close coordination with the electrical utility provider, Eversource, to ensure that the use of 3.8 acres of their land for the roadway project is compatible with their long-term plans. Based on comments received during the public review process of the draft report, the project development process should include an examination of the potential feasibility of maintaining a Route 6 westbound Exit 1C off-ramp only to Cranberry Highway via an at-grade connector road that extends from the relocated on- and off-ramps and parallels the eastern side of Route 6.

*Stage 4*

1. **Replacement of Bourne and Sagamore Bridges (by USACE) (Component H on Exhibit 5-5)**

2. **Reconstruction of Bourne and Sagamore Bridge Approaches (by MassDOT) (Components F & G on Exhibit 5-5)**

3. **Bourne Rotary Interchange (by MassDOT) (Component B-2 on Exhibit 5-5)**

Stage 4, combined with the other three project stages, would complete the implementation of the Case 3A transportation improvements.

*Benefit of Stage 4:* The implementation of the Stage 4 transportation improvements at the Sagamore Bridge area would substantially reduce delay on both Route 6 westbound and Route 3 southbound during both summer and non-summer peak periods.

With the reconstruction of the Bourne Rotary as a highway intersection, the Stage 4 improvements would eliminate nearly all delay at the Bourne Rotary during both the non-summer and summer peak periods. While Belmont Circle still experiences moderate delay during the summer peak period, Case 3A results in the greatest annual vehicle-hour savings than all other cases.

*Table 5-2 Recommended Multimodal Transportation Improvements*

| TRANSPORTATION MODE | RECOMMENDED IMPROVEMENT | LOCATION | MAJOR STAKEHOLDERS | COST ($ MILLION) |
|---|---|---|---|---|
| **MULTIMODAL** | | | | **2017 COST** |
| New bicycle/pedestrian connections to Canal bike trail | | Various locations in Bourne | Town of Bourne / MassDOT / USACE | $25K - $50K per location |
| Bicycle/Pedestrian Facility Improvements | | Sagamore Bridge Approaches / Adams Street | MassDOT / USACE | 3.9 |
| Bicycle/Pedestrian Facility Improvements | | Bourne Bridge Approach (north) | MassDOT / USACE | 0.8 |
| Bicycle/Pedestrian accommodation along bus routes: add sidewalks /crosswalks / roadway shoulder /bike racks / bus shelters | | Various locations along bus routes in Bourne & Sandwich | Towns of Bourne and Sandwich / MassDOT | Varies by location |
| Park and Ride Lot | | Route 6 Exit 2 (Route 130) | MassDOT | 2.8 |
| **LOCAL INTERSECTION ROADWAY IMPROVEMENTS** | | | | **2017 COST** |
| Route 6 at Cranberry Highway | | Bourne | Town of Bourne / MassDOT | 0.6 |
| Route 130 at Cotuit Road | | Sandwich | Town of Sandwich / MassDOT | 1.0 |
| Sandwich Road at Bourne Rotary Connector | | Bourne | Town of Bourne / MassDOT | 1.9 |
| **GATEWAY INTERSECTION ROADWAY IMPROVEMENTS (CASE 3A IMPROVEMENTS[1])** | | | | **2030 COST** |
| Scenic Highway to Route 25 Westbound Ramp | | | Town of Bourne / MassDOT | 11 |
| Belmont Circle Reconstruction | | | Town of Bourne / MassDOT | 23 |
| Bourne Rotary Interchange[2] | | | Town of Bourne / MassDOT | 87 |
| Route 6 Exit 1C Relocation | | | Town of Bourne / MassDOT | 51 |
| Additional Travel Lane on Route 6 Eastbound to Exit 2 | | | Towns of Bourne and Sandwich / MassDOT | 48 |
| Sagamore Bridge Approaches[3] | | | Town of Bourne / MassDOT / USACE | 64 |
| Bourne Bridge Approaches[3] | | | Town of Bourne / MassDOT / USACE | 84 |

*1 Case 3A assumes the prior replacement of the Sagamore and Bourne Bridge by the USACE.*
*2 Includes cost of Bourne Rotary Reconstruction (Alternative 2, Three Signalized Intersections).*
*3 Includes approach roadway and bridge relocation and retaining walls.*

Challenges of Stage 4: The replacement of the Bourne and Sagamore Bridges and related approach work would be a large-scale project requiring state and federal environmental planning studies and other major environmental permits. The environmental planning, permitting, and design phase will require close and sustained coordination between MassDOT, the USACE, and Cape Cod stakeholders.

The location and conceptual cost of all recommended transportation improvements are provided in Table 5-2.

## 5.5 IMPLEMENTATION

This section describes the steps involved in advancing the recommended projects through MassDOT's project development and design process. Although some steps occur simultaneously, they generally occur in the order presented. These steps include project planning, initiation, design, environmental permitting, right-of-way process, programming (funding), procurement, construction, and assessment.

### 5.5.1 MassDOT Project Development and Design Process

The development of transportation improvements is a complex decision-making process that involves many stakeholders, decision makers, and reviewing agencies. All projects developed by or with the involvement of the MassDOT Highway Division are guided by the eight-step process outlined in Chapter 2 of the MassDOT Highway Division's Project Development and Design Guide. This process guides a proposed transportation improvement from concept through design and construction and is designed to ensure that projects meet their stated goals and objectives.

This project development process is a requirement for all projects involving the MassDOT Highway Division, including projects in which the Highway Division is the project proponent, is responsible for project funding, or controls the infrastructure in question (projects on state highways). In the case of projects involving roadways or other infrastructure and property under the jurisdiction of Cape Cod municipalities, project development and implementation are the municipality's responsibility. Examples of recommendations falling under municipal jurisdiction include local roads and signalization improvements, sidewalk/ADA improvements, and other pedestrian/bicycle infrastructure.

The eight major steps that constitute the MassDOT Project Development and Design Process are outlined below and range from the first steps of identifying a project need toward greater

refinement of the project's focus, design details, and ultimately toward implementation. The first two steps, Needs Identification and Planning, are addressed in this study.

**Step 1: Needs Identification**

For each of the locations at which an improvement is to be implemented, MassDOT leads an effort to define the problem, establishes project goals and objectives, and define the scope of the planning needed for implementation. To that end, MassDOT completes a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facilities or locations. The PNF documents the problems and explains why corrective action is needed. The information defining the need for the project would be drawn primarily from this planning study. At this point in the process, MassDOT also meets with potential project participants to allow for an informal review of the project. For the transportation improvements recommended in this study, potential participants include the Cape Cod Commission, the U.S. Army Corps of Engineers (USACE), local elected officials, community members, and the other stakeholders that have participated in the public engagement process for this study.

The PNF is reviewed by the MassDOT Highway Division office whose jurisdiction includes the location of the proposed project. For the improvements recommended in this study, this is the District 5 office. MassDOT would also send the PNF to the Cape Cod Commission, the regional Metropolitan Planning Organization (MPO), for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and therefore whether it is ready to move forward into the design phase or whether it should be dismissed from further consideration.

**Step 2: Planning**

This phase would likely not be required for the implementation of the improvements proposed in the Cape Cod Canal Transportation Study, as this study should constitute the outcome of this step. However, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained so that the subsequent design and permitting processes are understood.

The level of planning needed varies widely based on the complexity of the project. Typical tasks include the following: define the existing context, confirm the project need, establish

goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide report documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design or a recommendation to delay the project or dismiss it from further consideration.

For this study, continued coordination with the USACE will be critical to properly define future projects and the responsibilities of each agency related to design, permitting, and construction.

**Step 3: Project Initiation**

At this point in the process, the proponent, MassDOT Highway Division, completes a Project Initiation Form (PIF) for each improvement, which is reviewed by the MassDOT Project Review Committee (PRC) and the MPO, in this case the Cape Cod Commission. The MassDOT PRC is composed of MassDOT staff members including the Chief Engineer, each District Highway Director, representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic, and Bridge Departments, and the Federal-Aid Program Office (FAPRO).

The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First, the PRC reviews and evaluates the proposed project based on the MassDOT's statewide priorities and criteria. If the result is positive, MassDOT Highway Division moves the project forward to the design phase and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign a project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

Given transportation funding constraints, prioritization of the recommendations for implementation will need to be established regionally by the Cape Cod Commission, member communities, and MassDOT, in particular for the gateway intersection improvements recommended in Section 5.4.2.

*USACE Coordination*

MassDOT will continue to coordinate with the USACE related to the development and permitting of the transportation improvements in the Canal area and their efforts to secure

federal funding for the assumed replacement of the Bourne and Sagamore Bridges.

**Step 4: Public Outreach, Environmental Permitting, Design, and Right-of-Way Process**

This step has four distinct but closely integrated elements: Public Outreach, Environmental Documentation and Permitting, Design, and Right-of-Way Acquisition. The outcome of this step is a fully designed and permitted project ready for construction.

The sections below provide more detailed information on the four elements of this step of the project development process.

**Public Outreach:** Continued public outreach in the design and environmental process is essential to maintain public support for the project and to seek meaningful input on the design elements. The public outreach is often in the form of required public hearings (conducted at the 25% design milestones) but can also include less formal dialogue with those interested in and affected by a proposed project.

Given the size and complexity of the transportation improvements recommended in this study, on-going public outreach meetings are anticipated with the public, the study Working Group, local elected officials, and other stakeholders.

**Environmental Planning and Permitting:** The MassDOT Highway Division will be responsible for identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for both the Massachusetts Environmental Protection Act (MEPA) and the National Environmental Protection Act (NEPA).

As the Canal bridges are owned by the USACE, they have responsibility for the environmental documentation and permitting of the assumed replacement of the Canal bridges. However, in certain circumstances, projects involving multiple federal agencies (in this case, the USACE and the Federal Highway Administration [FHWA]), a lead federal agency is identified to manage the environmental planning and permitting process.

Environmental documentation and permitting are typically completed in conjunction with the Preliminary Design phase described below.

**Design:** The MassDOT project development process involves three major phases of design. The first is Preliminary Design, also referred to as the 25% submission. The major components of

this phase include a full survey of the project area, preparation of base plans, development of basic geometric layout, development of preliminary cost estimates, and submission of a functional design report. Preliminary Design is often completed in conjunction with Environmental Planning and Permitting. The next phase is Final Design, which is also referred to as the 75% and 100% submissions. The major components of these phases include preparation of a subsurface exploratory plan (if required), coordination of utility relocations, development of temporary traffic control plans through construction zones, development of final cost estimates, and refinement and finalization of the construction plans. Once Final Design is complete, a full set of Plans, Specifications, and Estimates (PS&E) is developed for the project.

**Right-of-Way Acquisition:** A separate set of Right-of-Way plans is required for any project that requires land acquisition or easements. These plans are developed concurrent with the 25% and 75% highways design plans and must identify the existing and proposed layout lines, easements, property lines, names of property owners, and the dimensions and areas of estimated takings and easements.

**Step 5: Programming (Identification of Funding)**

Programming, which typically begins during the design phase, can occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, the project proponent requests that the MPO include a project from the Regional Transportation Plan in the region's annual Transportation Improvement Plan (TIP) development process. The proponent requesting the project's listing on the TIP can be the community or one of the MPO member agencies (the Regional Planning Agency, MassDOT, or the Regional Transit Authority). The MPO considers the project in terms of state and regional needs, funding availability, project readiness, evaluation criteria, and compliance with the Regional Transportation Plan. If the MPO decides to include the project in the TIP, it is first included in the Draft TIP for public review and then in the Final TIP. A project does not have to be fully designed for the MPO to program it in the TIP, but generally a project has reached 75 percent design to be programmed in the year-one element of the four-year TIP.

While securing funding through the MPO's TIP process is important, the cost of some of the larger the improvements recommended in this study are well beyond the level of funding the MPO typically has to allocate to projects in this region. Additional funding sources must be identified to advance these

projects. As noted, the USACE would be responsible for securing federal funding for the assumed replacement of the Bourne and Sagamore Bridges.

**Step 6: Procurement**

Following project design and programming of a highway project, the MassDOT Highway Division publishes a request for proposals, which is also often referred to as being "advertised" for construction. MassDOT then reviews the bids and awards the contract(s) to the qualified bidder with the lowest bid.

**Step 7: Construction**

After a construction contract is awarded, MassDOT Highway Division and the contractor develop a public participation plan and a temporary traffic control plan for the construction process.

**Step 8: Project Assessment**

The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects. The Project Development and Design Process steps detailed above, along with their effect on the project schedule and typical durations associated with each step.

### 5.5.2 Project Delivery Methods

The following sections describe three common project delivery methods for highway projects. MassDOT and the USACE would be responsible for selecting the project delivery method that best balances cost, risk, construction schedule, and inconvenience to the residents and visitors to Cape Cod.

#### *Design-Bid-Build (D-B-B)*

The project development process described previously is based on a conventional project delivery method, commonly referred to as "Design-Bid-Build" (D-B-B). The essence of the D-B-B process is that the project is designed to the PS&E level and then advertised for construction, i.e. the design and construction are carried out sequentially. Under this scenario, the engineer of record (designer) and the construction contractor are two separate contracting entities.

#### *Design-Build (D-B)*

The design-build project delivery process is a method to deliver a project in which the design and construction services

are contracted by a single team. This process occurs after the completion of the environmental planning and 25% design phase. This type of project delivery process often takes less time than a traditional design-bid-build process because design and construction process happen at the same time.

#### *Public-Private Partnership (P3)*

An infrastructure P3 is generally a method of project delivery in which a private entity designs, constructs, finances, and manages a facility in exchange for a portion of the funds generated or through availability payments. In the case of a highway P3 project, the funds generated by the project are generally the tolls charged to users of the facility. A benefit of this type of project delivery process is that the project owner (in this case, MassDOT) does not have to fund the design or construction of the project.

### 5.5.3 Environmental Considerations

This section provides a summary of the environmental documentation, review, and permitting that would need to be conducted for any alternative to be implemented. Any project will need to follow the project development design process (Step 4), which includes identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for MEPA and NEPA. Expected environmental policy acts and permitting application and reviews are discussed below but may vary depending upon actual project design and impacts.

#### *Environmental Policy Acts*

Both the Massachusetts and National Environmental Policy Acts (MEPA and NEPA) require an evaluation of a range of alternatives to identify the alternative that meets the project's purpose and need with the least impact to social and natural environmental resources. Mitigation for all environmental impacts must be identified. Based on the scope of the anticipated highway improvements, it is anticipated that MEPA review will at least consist of an Environmental Notification Form (ENF) and a Draft and Final Environmental Impact Report (EIR). Similar thresholds apply to NEPA where a full Environmental Assessment (EA) or Environmental Impact Statement could be warranted for this project.

#### *Environmental Reviews/Permits*

Local, state, and federal agency regulatory agencies will review proposed activities with respect to applicable environmental laws and regulations. The following state and federal regulatory

agency reviews and permits would likely be required for the recommended projects:

*State Agency Review/Approval*

- Massachusetts Environmental Policy Act
- Massachusetts Wetlands Protection Act (WPA) – Wetlands Notice of Intent (NOI)
- Massachusetts Division of Fisheries, Natural Heritage and Endangered Species Program review
- Massachusetts General Law Chapter 21E and the Massachusetts Contingency Plan (MCP) (hazardous materials review)

*Federal Agency Review/Approval*

- National Environmental Policy Act
- Section 404 Permit – U.S. Army Corps of Engineers (USACE) General Permit
- Section 401 of the Federal Clean Water Act – 401 Water Quality Certification
- Section 106 National Historic Preservation Act (managed by the Massachusetts Historical Commission (MHC))
- Endangered Species Act – Section 7 review
- Environmental Protection Agency (EPA) Construction Stormwater General Permit

### 5.5.4 Climate Change Considerations

MassDOT has a goal of reducing transportation vulnerabilities and adapting infrastructure for current and future climate change impacts. MassDOT has completed several studies and has a number of active projects underway that will help to better assess the potential impacts of climate change and severe weather to the Commonwealth's transportation infrastructure. A summary of MassDOT's Climate Change Resiliency pilot projects and statewide mapping products can be found on their website using this link: https://www.mass.gov/info-details/climate-change-resiliency#additional-resiliency-projects-underway-.

In addition, MassDOT, through the Executive Office of Energy and Environmental Affairs, (EEA) and the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, is also working with other state and federal agencies to develop statewide policies and best management practices to adapt to climate change hazards and improve resiliency.

MassDOT is also reviewing its internal policies and procedures to integrate resiliency into the planning and project development

processes. While those policies and procedures are being developed, projects are being reviewed on a case-by-case basis.

A high-level vulnerability assessment of the study area focused on flood risk, revealed that several roadways near the western end of the Canal and Buttermilk Bay are within the 100-year flood zones and will increasingly be vulnerable to flooding with forecast sea level rise and increasing storm intensity. These roadways include portions of Main Street, Buzzards Bay Bypass, and Belmont Circle in Bourne and Cranberry Highway and Head of the Bay Road in Wareham. At the eastern side of the Canal, portions of Scusset Beach Road and Route 6A are within the 100-year flood zone. MassDOT will incorporate increased flood risk while designing transportation improvements in these areas.

### 5.5.5 Implementation Summary

As part of this study, several multimodal transportation improvement projects have been outlined. It is recommended that all of these improvements should be considered for project development. It is imperative that municipal leadership from Bourne and Sandwich, as well as the Cape Cod Commission, area Chambers of Commerce,  members of the broader community, the USACE, and MassDOT continue to coordinate and further define the most appropriate and urgent projects. In addition, continued support from local and regional stakeholders in advancing high-priority projects is critical to successfully implementing this agenda. These local priorities should inform time lines and programming for each improvement to proceed to project development.

massDOT
Massachusetts Department of Transportation

# CAPE COD CANAL
## TRANSPORTATION STUDY

Prepared by:
Stantec

# Appendices

# Appendix A:
# Public Involvement Plan

March 23, 2015

Public Involvement Plan

The Public Involvement Plan is designed to elicit detailed and comprehensive comments on the study concept. The Public Involvement Plan includes the forms of communication, the target audiences, and the draft agendas for the organized meetings. The Public Involvement Plan is designed and will be executed to the fullest extent possible for full and fair participation of minority, low-income, and other disadvantaged populations.

Public Participation Principles

The Public Involvement Plan has been developed in consistency with MassDOT's Accessible Meeting Policy Directive, and it will also guide civic engagement for the study by emphasizing the following principles:

The public will learn about or become engaged in the study in a variety of primary ways: Methods will include public informational meetings, Working Group meetings, the study website, local newspapers articles, and study newsletters.

The public shall have access to information about the study: A record of all the study's public informational and Working Group meetings will be kept, such as meeting presentations, summaries and handout material. These documents will be posted on the website in a timely manner and in compliance with Section 508 of the U.S. Rehabilitation Act of 1973 that provides accessible electronic documents to those with disabilities. Additionally, copies of the draft and final report will be available at the local public libraries.

The public shall be presented with clear and accessible information: Information will be clearly written, and technical terms and regulatory procedures will be explained to the extent possible. Language translation will be provided for written materials such as meeting flyers and newsletters/bulletins, as well as at public informational meetings.

The public shall be able to engage with a responsive study team: The public and Working Group will receive sufficient notice of meetings, and all efforts will be made to schedule the meetings at a time and place that is convenient, comfortable, and accessible. Ample time to review any materials will also be provided to the extent possible. All public questions and inquiries will be answered in a timely manner.

The public shall be able to participate in a process that is well coordinated: Good coordination, communication, and collaboration among all involved agencies and community organizations will be provided to the public with the most current and accurate information and material.

All public outreach will be conducted in a manner that is inclusive and sensitive, especially to the needs of identified Environmental Justice and Title VI populations. Meetings will be held in facilities that are ADA compliant and follow MassDOT's Accessible Meeting Policy directive. The Cape Cod Commission's analysis of Limited English Proficiency populations within the study area was utilized to determine language translation needs for publicity materials (press releases and newsletters) and interpretive services at public informational meetings. Cape Cod Commission's analysis conducted for the Cape Cod Metropolitan Planning Organization determined a need for Portuguese and Spanish language translation in the outreach program.

Communications Lists and Forms of Outreach

In consultation with MassDOT, prepare a list of individuals and entities that will receive communications about the project. Send information through multiple levels of communication including:

- Broadcast e-notices [e-mail] of website updates and meeting notices,
- Media notices
- E-mail notices and attachments of project documents, specifically for Working Group members and individuals participating in the Working Group meetings,
- E-mail notices of meetings and project documents to MassDOT Highway Division for coordination.

The public email account and the Working Group e-mail account will be processed through govdelivery.com. Social media will be monitored for trending comments related to the project.

Confirmation of Working Group Members

The consultant and MassDOT will confirm membership of the Working Group, with the options for different levels of membership; full members, with alternate and associate members. The main group of participants to be invited include:

- Legislators: William Keating, Dan Wolf, Marc Pacheco, Robert Hedlund, Therese Murray, Randy Hunt, David Viera, Timothy Madden, Susan Williams Gifford, with additional legislators on the

notification list,

- Massachusetts Department of Environmental Protection,
- Massachusetts Office of Coastal Zone Management,
- Massachusetts Historical Commission,
- Massachusetts Division of Marine Fisheries,
- National Heritage and Endangered Species Program,
- Massachusetts Division of Energy Resources,
- Army Corps of Engineers
- Federal Highway Administration
- Cape Cod Commission,
- Southeastern Regional Planning and Economic Development District,
- Old Colony Planning Council,
- Cape Cod Canal Area Traffic Task Force,
- Cape Cod Canal Region Chamber of Commerce,
- Cape Cod Chamber of Commerce,
- Representatives from the municipalities of Bourne, Sandwich, Plymouth and Wareham (invites to the Boards of Selectmen).

In addition, the recommendation is to consider participation from:

- Wampanoag Tribe of Gay Head (Aquinnah)
- Massachusetts Maritime Academy
- CCRTA
- GATRA
- Woods Hole, Martha's Vineyard & Nantucket Steamship Authority
- Peter Pan Bus Lines
- Plymouth & Brockton Bus Lines

Working Group Meetings

Working Group meetings will be scheduled at key project milestones with input from the members, and will be conducted by MassDOT Planning and the consultant. Up to eight (8) Working Group meetings are proposed to be scheduled, as needed, with rotating meeting locations within the Upper Cape towns of Wareham, Bourne, Mashpee, Sandwich, and Falmouth.

The first Working Group meeting will be scheduled with an agenda to present and discuss:

- Study Area limits;

- Draft Mission Statement, Project Goals and Objectives;

- Draft Evaluation Criteria for the project alternatives;

- Outline and explanation of current and future project phases; and,
- Working Group comment on these elements.

The subsequent Working Group meetings will have the following agendas:

- Review and discussion of the Final Problem Statement, Mission Statement and Project Goals
- Review of the Project Assessments and Evaluation Criteria
- Review of Preliminary Alternatives and application of Evaluation Criteria
- Recommendations for Advancement of the Project
- Review the results of the Public Informational Meetings

An option includes the formation of subgroups from the membership of the Working Group to focus on specific issues.

Public Informational Meetings

Public meetings will be scheduled and publicized by MassDOT Planning and the consultant. The consultant will prepare draft public notices for MassDOT to review, approve and distribute. The publicity will include notice of the availability of foreign language (at a minimum Spanish and Portuguese) and sign language interpreters, and the ability to provide other accommodations for disabilities and for full and fair accommodation to attract broad participation.

MassDOT and the consultant will conduct public informational meetings at major project milestones. Proposed are four Public Informational Meetings to be scheduled. The Public Informational Meetings will have the overall purpose of responding to public questions and confirmation of the content of the presentation, and will be organized according to the following agendas:

- Presentation of the Problem Statement
- Presentation of the Conditions Assessments
- Presentation of Preliminary Alternatives and Evaluations

- Presentation of the Future Project Schedule with points identified for input and participation

The Public Informational Meetings will be scheduled to present information to the general public between Working Group meetings where the information will be presented and discussed together with review of the results of the Public Informational Meetings.

The Public Informational Meetings will be located at venues within the Upper Cape area of Plymouth, Wareham, Sandwich, Falmouth and Mashpee. Two additional Regional Public Informational Meetings will be held on the Lower Cape [Orleans, Brewster, Harwich, Chatham], and Mid-Cape [Barnstable, Yarmouth, Dennis]. The regional meetings will include presentation of the drafts of the problem statement, condition assessments, preliminary alternatives and evaluations, and future project schedule.

Special Events

Participation in special, open public events that may be scheduled by others during the course of the study would be opportunities for further dissemination of information. These may include special events and summer festivals such as the regional oyster and cranberry festivals, or institutional events where a booth or table could be arranged, or project specific historic events such as the 100th anniversary of the bridges and canal. Up to four (4) events could be planned and included in the work program.

Presentation and Display Materials

The consultant shall be responsible for the preparation of presentation and display materials for Working Group meetings and Public Informational Meetings. These materials shall be prepared one week in advance to allow MassDOT time for review and approval. The consultant will be available one week in advance of the meetings to present presentation materials to MassDOT.

Coordination

The consultant will share materials prepared as part of this study with the MassDOT Highway Division to support the public involvement plan for the traffic improvement project for Belmont Circle (Buzzards Bay Bypass – Routes 6 and 28, Route 25 and Main Street) and attend up to four (4) meetings on this project to provide input and information generated from the Canal study project.

Project Website

Any project website will be created, maintained, and updated by MassDOT. The consultant will provide content data for development of this website from the project tasks including relevant historical documents, task deliverables, and both pre-and post-meeting materials. These will be submitted to the MassDOT project manager for posting on the project website.

The web content provided by the consultant will be presented as Web Content Accessibility Guidelines (WCAG) 2.0 compliant and with each digital file sized at or under 4Mb.

*Proposed Project Meetings*:

- Working Group – Eight (8) meetings
- Public Informational Meetings – Four (4) meetings
- Regional Public Informational Meetings – Two (2) meetings
- Special Events – Four (4) events
- Highway Division Coordination - Four (4) meetings

# Appendix B:
# MESA Information Form and MNHESP Response

DIVISION OF
**FISHERIES & WILDLIFE**

1 Rabbit Hill Road, Westborough, MA 01581
p: (508) 389-6300 | f: (508) 389-7890
MASS.GOV/MASSWILDLIFE

Jack Buckley, *Director*

MASSWILDLIFE

December 15, 2016

Sean Hale
Normandeau Associates, Inc.
550 Forest Ave, Suite 201
Portland, ME 04101

RE: Project Location: Cape Cod Canal Bridge
Town: BOURNE
**NHESP Tracking No.: 14-33419**

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program of the MA Division of Fisheries & Wildlife (the "Division") for information regarding state-listed rare species in the vicinity of the above referenced site. Based on the information provided, this project site, or a portion thereof, is located **within** *Priority Habitat* and *Estimated Habitat* as indicated in the *Massachusetts Natural Heritage Atlas* (13th Edition). Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Bourne Bridge

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Acronicta albarufa* | Barrens Dagger Moth | Butterflies and Moths | Threatened |
| *Catocala herodias gerhardi* | Gerhard's Underwing Moth | Butterflies and Moths | Special Concern |
| *Cicinnus melsheimeri* | Melsheimer's Sack Bearer | Butterflies and Moths | Threatened |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Speranza exonerata* | Pine Barrens Speranza | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Middle Bridge

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Relocated Exit 1

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Route 3 to Route 25

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |

Route 3 to Route 6 HOV

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Caprimulgus vociferus* | Eastern Whip-poor-will | Bird | Special Concern |
| *Cingilia catenaria* | Chain Dot Geometer | Butterflies and Moths | Special Concern |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Route 6 to Route 25 HOV

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Caprimulgus vociferus* | Eastern Whip-poor-will | Bird | Special Concern |
| *Cingilia catenaria* | Chain Dot Geometer | Butterflies and Moths | Special Concern |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Sagamore Twin

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Caprimulgus vociferus* | Eastern Whip-poor-will | Bird | Special Concern |
| *Cingilia catenaria* | Chain Dot Geometer | Butterflies and Moths | Special Concern |
| *Circus cyaneus* | Northern Harrier | Bird | Threatened |
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Sandwich Road

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Acronicta albarufa* | Barrens Dagger Moth | Butterflies and Moths | Threatened |
| *Catocala herodias gerhardi* | Gerhard's Underwing Moth | Butterflies and Moths | Special Concern |
| *Cicinnus melsheimeri* | Melsheimer's Sack Bearer | Butterflies and Moths | Threatened |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |

MASSWILDLIFE

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Speranza exonerata* | Pine Barrens Speranza | Butterflies and Moths | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Scenic Highway

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |

Focus Area

| Scientific name | Common Name | Taxonomic Group | State Status |
|---|---|---|---|
| *Abagrotis nefascia* | Coastal Heathland Cutworm | Butterflies and Moths | Special Concern |
| *Acronicta albarufa* | Barrens Dagger Moth | Butterflies and Moths | Threatened |
| *Caprimulgus vociferus* | Eastern Whip-poor-will | Bird | Special Concern |
| *Catocala herodias gerhardi* | Gerhard's Underwing Moth | Butterflies and Moths | Special Concern |
| *Cicinnus melsheimeri* | Melsheimer's Sack Bearer | Butterflies and Moths | Threatened |
| *Cingilia catenaria* | Chain Dot Geometer | Butterflies and Moths | Special Concern |
| *Euchlaena madusaria* | Sandplain Euchlaena | Butterflies and Moths | Special Concern |
| *Hemaris gracilis* | Slender Clearwing Sphinx | Butterflies and Moths | Special Concern |
| *Hemileuca maia* | Barrens Buckmoth | Butterflies and Moths | Special Concern |
| *Leptodea ochracea* | Tidewater Mucket | Mussel | Special Concern |
| *Lycia ypsilon* | Pine Barrens Lycia | Butterflies and Moths | Threatened |
| *Malaclemys terrapin* | Diamond-backed Terrapin | Reptile | Threatened |
| *Metarranthis pilosaria* | Coastal Swamp Metarranthis Moth | Butterflies and Moths | Special Concern |
| *Ophioglossum pusillum* | Adder's-Tongue Fern | Plant | Threatened |
| *Speranza exonerata* | Pine Barrens Speranza | Butterflies and Moths | Special Concern |
| *Sterna dougallii* | Roseate Tern | Bird | Endangered |
| *Sterna hirundo* | Common Tern | Bird | Special Concern |
| *Terrapene carolina* | Eastern Box Turtle | Reptile | Special Concern |
| *Triosteum perfoliatum* | Broad Tinker's-Weed | Plant | Endangered |
| *Zale lunifera* | Pine Barrens Zale | Butterflies and Moths | Special Concern |

The species listed above are protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.mass.gov/nhesp). If you have any questions regarding this letter please contact Emily Holt, Endangered Species Review Assistant, at (508) 389-6385.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

NORMANDEAU ASSOCIATES
Environmental Consultants

November 21, 2016

Dave Paulson, Regulatory Review
Natural Heritage and Endangered Species Program
MA Division of Fisheries & Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

**RE: MESA Information Request Form - Cape Cod Canal Transportation Study**
**NHESP Tracking No. 14-33419**

Dear Mr. Paulson & Regulatory Review Staff:

On behalf and at the request of the Massachusetts Department of Transportation, Highway Division ("MassDOT" or the "Project Proponent"), Normandeau Associates, Inc. ("Normandeau") is pleased to submit this MESA Information Request Form and supporting materials associated with MassDOT's ongoing Cape Cod Canal Transportation Study.

**Cape Cod Canal Transportation Study Overview**

MassDOT, in collaboration with others, is currently conducting the Cape Cod Canal Transportation Study. The goals of the study are to improve multimodal mobility in the Cape Cod Canal Area and to establish an alternative or replacement crossing of the Cape Cod Canal to address the diminishing quality of year-round connectivity over the canal. The Sagamore and Bourne Bridges are the primary means of access to and from the mainland for the 15 towns and 215,000 people who live on Cape Cod. While in previous years off-season mobility over the bridges was unimpeded, the two functionally obsolete bridges are 80 years old and have required increased maintenance by the U.S Army Corps of Engineers. This maintenance has and will continue to necessitate lane closures and resulting delays with increasing frequency. This will have a significant impact on emergency access and safety, community connectivity, and impacts to the economic activity of Cape Cod.

The Cape Cod Canal Transportation Study seeks to identify existing and future multimodal transportation deficiencies and needs around the Cape Cod Canal area in Bourne and Sandwich. The study entails the development and analysis of a full range of transportation alternatives including highway, interchange, and non-highway improvements, as well as options and design elements that will improve access for all modes. The alternatives considered also include the

evaluation of potential alignments for an additional or replacement crossing over the Cape Cod Canal.

**MESA Information Request**

As part of the study, MassDOT is assessing potential impacts to natural and cultural resources that may result from transportation improvements in the Cape Cod Canal area. To facilitate this impact analysis, potential project areas have been divided into a larger Focus Area and eleven (11) Canal Crossing and Approach Options, as listed below and presented in the attached figures (see MESA Information Request Form & Canal Crossing & Approach Options in Attachment A):

- Middle Bridge 1
- Middle Bridge 2
- Sandwich Road
- Relocated Exit 1
- Route 3 to Route 25
- Sagamore Twin
- Scenic Highway
- Bourne Bridge & Connections at Belmont Circle and Bourne Rotary
- Route 3 to Route 6 HOV
- Route 6 to Route 25 HOV SH Alt
- Route 6 to Route 25 HOV
- Focus Area

Natural resources in the vicinity of these options include waterways and wetlands, FEMA Flood Hazard Areas, fisheries resources, and rare and endangered species habitat as mapped by the Natural Heritage and Endangered Species Program ("NHESP"). A prior Information Request submitted to NHESP (Tracking No. 14-33419) identified 43 reptile, bird, butterflies and moths, mussel, and plant species listed as endangered, threatened, or special concern and occurring in Priority and Estimated Habitats within the overall study area.

This Information Request is being submitted with potential transportation improvements divided into the above-listed project options. Each option consists of a potential work area consisting of the roadway section and a conservative 200-foot buffer (i.e. limit of work). This second Information Request is being submitted to enable a direct comparison of all canal crossing and approach options with regard to potential impacts to rare species and their habitats. As such, MassDOT is requesting that NHESP provide separate inventories of state-listed rare species for each project option as identified above and in the attached figures. In order for NHESP to review

each project option and provide specific project option species lists according to the NHESP species database, this submittal includes GIS datalayers of the project options and focus area.

Please do not hesitate to contact me with any questions regarding this request or if additional information or materials is required. I can be reached via email at shale@normandeau.com or by telephone at 207-518-6763. Thank you.

NORMANDEAU ASSOCIATES, INC.

S. D. H

Sean D. Hale, CWS, PWS
Senior Scientist

CC: Timothy Dexter, MassDOT
Ethan Britland, MassDOT
Michael J. Paiewonsky, Stantec
Tory Fletcher, Normandeau Associates, Inc.

# Attachment A – MESA Information Request form & Figures

# MESA Information Request Form

Please complete this form to request site-specific information from the Natural Heritage & Endangered Species Program (Please submit only one project per request form).

**Please include a check for $50.00 made out to Comm. of MA – NHESP.***

**Requestor Information**

Name: Susan McArthur

Affiliation: Massachusetts Department of Transportation, Highway Division ("MassDOT")

Address: 10 Park Plaza, Room 4260

City: Boston State: MA Zip Code: 02116

Daytime Phone: 1-857-368-8807 Ext. Email address: susan.mcarthur@state.ma.us

**Project Information**

Project or Site Name: Cape Cod Canal Transportation Study

Location: Proximate to Cape Cod Canal Town: Bourne, Plymouth, Sandwich

Name of Landowner or Project Proponent: MassDOT

Acreage of the Property: Focus area-7,272 options-1,303

Description of Proposed Project and Current Site Conditions: (If necessary attach additional sheet)

The goal of the Cape Cod Canal Transportation Study is to improve multimodal mobility in the Cape Cod Canal area, including evaluation of transportation improvements in the canal area to address diminishing connectivity quality over the canal due to the aging Sagamore and Bourne Bridges. Objectives include creation of reliable multimodal connectivity and mobility such that quality of life on Cape Cod is not diminished by unreliable connectivity. Reliable multimodal connections across the canal will also maintain and enhance public safety. See attached letter/figures.

- ☑ Will this project be reviewed as a Notice of Intent by the local Conservation Commission?
- ☑ Will this project be undergoing MEPA review for reasons other than rare species?
- ☑ Have you enclosed the required copy of a USGS topographic map in the scale 1:24,000 or 1:25,000 (not copy reduced) with the site location clearly marked and centered on the copy page? (Copies of Natural Heritage Atlas pages are not accepted)

Please **mail** this completed form and topographic map to:

Regulatory Review
Natural Heritage and Endangered Species Program
MA Division of Fisheries and Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

**Questions regarding this form should be directed according to the county that the property is located**:
Berkshire, Essex, Franklin, Hampshire, Hampden, Middlesex & Worcester Counties call: 508-389-6361
Barnstable, Bristol, Dukes, Nantucket, Norfolk, Plymouth & Suffolk Counties call: 508-389-6385

**Persons requesting information will receive a written response within 30 days of receipt of all information required.** Please do not ask for an expedited review. ***If you are requesting information for habitat management or conservation purposes and you are a non-profit conservation group, government agency or working with a government agency please fill out a Data Release Form.

September 2014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G:\Projects\GIS_Projects_2016\Cape_Cod\MXD\CC_TopoOverview_112116.mxd


MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
FOCUS AREA
Plymouth, Bourne & Sandwich, MA
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
Index Map
Site Features
Focus Area
N
1:32,000
0
0.25
0.5
1
Miles
NORMANDEAU ASSOCIATES
Environmental Consultants
SANDWICH
SANDWICH
BOURNE
BOURNE
PLYMOUTH
WAREHAM
WAREHAM
Data Provided by: ESRI, Stantec & MassGIS
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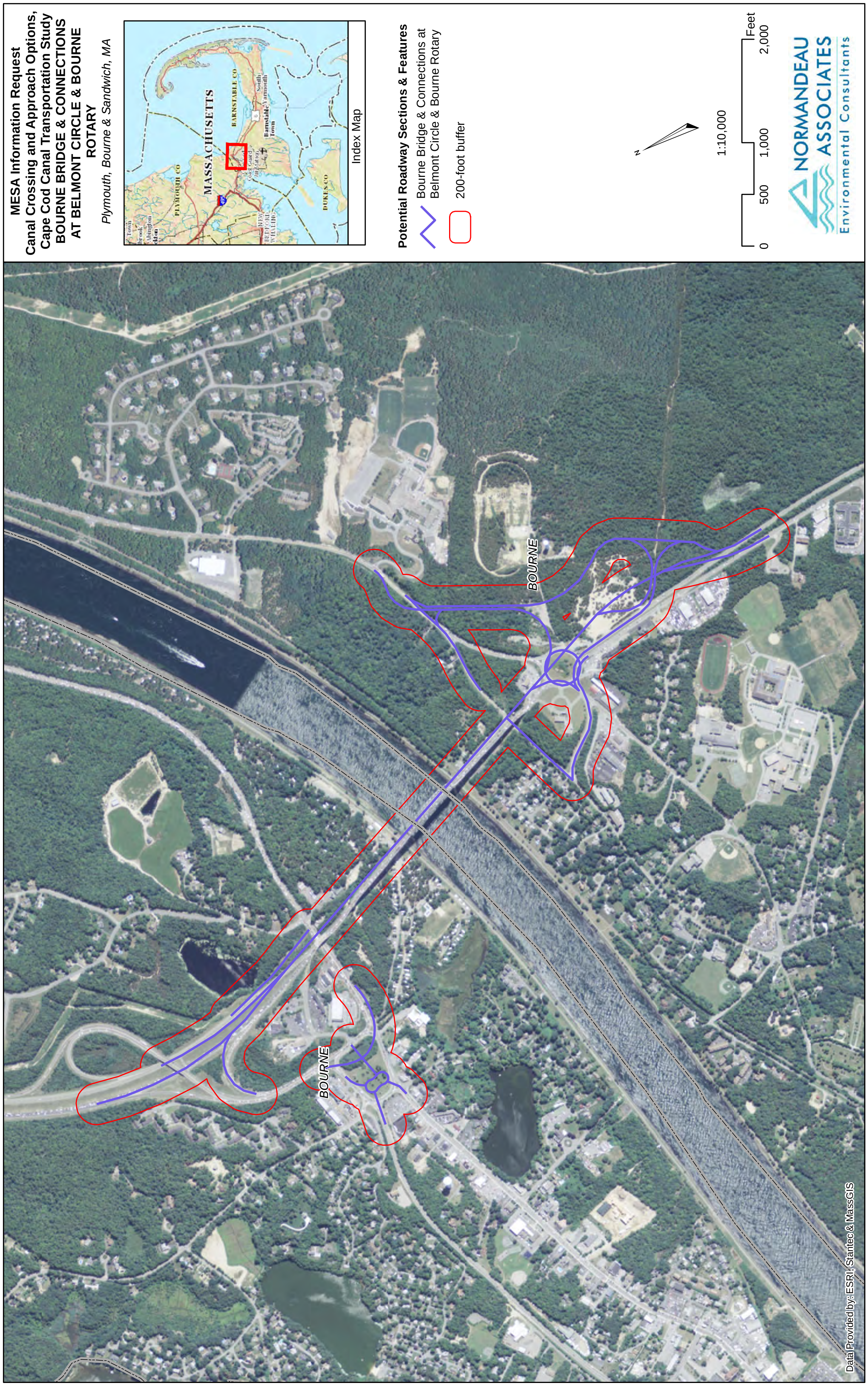

MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
BOURNE BRIDGE & CONNECTIONS
AT BELMONT CIRCLE & BOURNE
ROTARY
Plymouth, Bourne & Sandwich, MA
Index Map
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
Potential Roadway Sections & Features
Bourne Bridge & Connections at Belmont Circle & Bourne Rotary
200-foot buffer
N
1:10,000
0 500 1,000 2,000 Feet
NORMANDEAU ASSOCIATES
Environmental Consultants
BOURNE
BOURNE
Data Provided by: ESRI, Stantec & MassGIS
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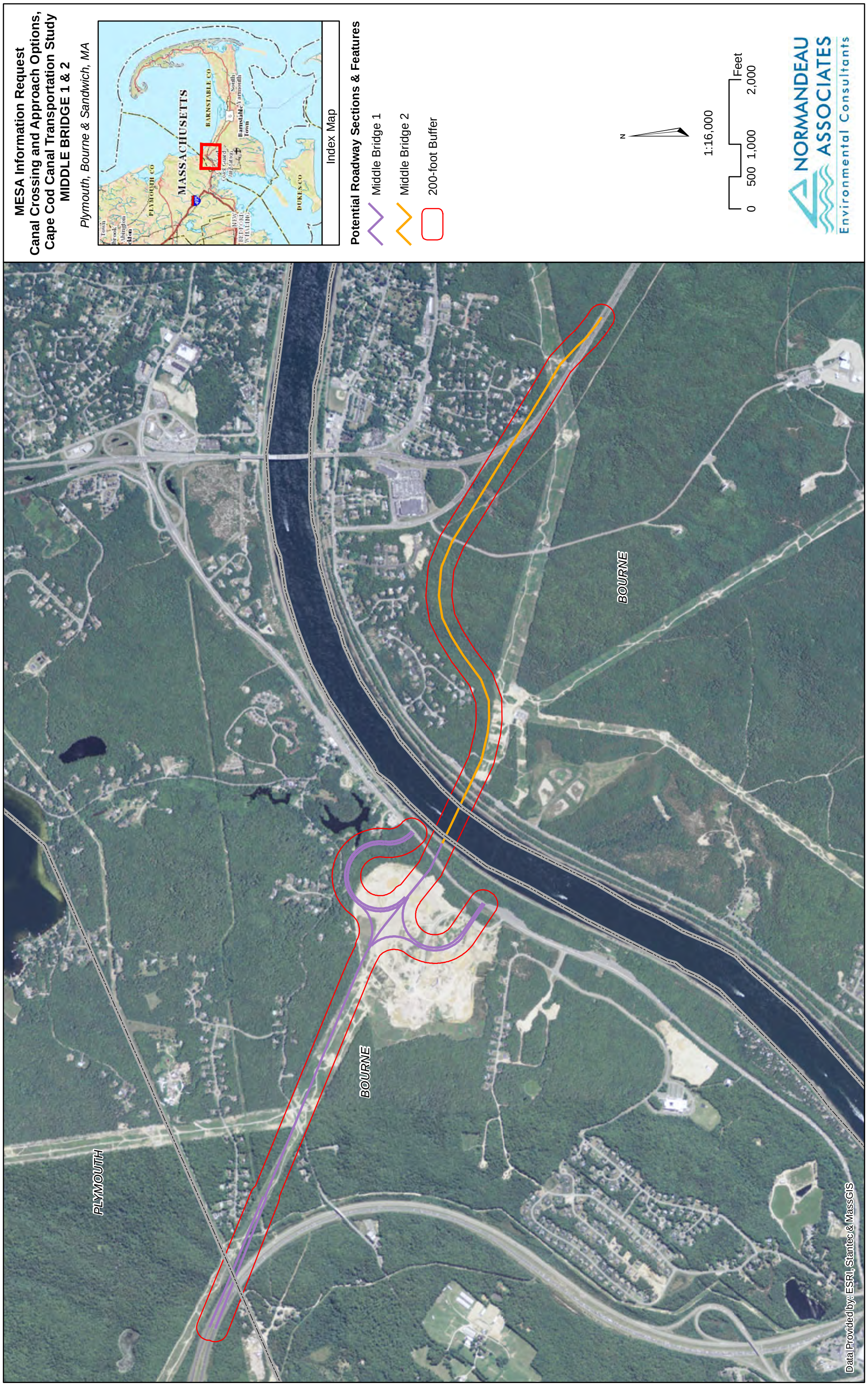

MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
MIDDLE BRIDGE 1 & 2
Plymouth, Bourne & Sandwich, MA
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
Index Map
Potential Roadway Sections & Features
Middle Bridge 1
Middle Bridge 2
200-foot Buffer
N
1:16,000
0 500 1,000 2,000
Feet
NORMANDEAU ASSOCIATES
Environmental Consultants
BOURNE
BOURNE
PLYMOUTH
Data Provided by: ESRI, Stantec & MassGIS
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MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
SAGAMORE TWIN
Plymouth, Bourne & Sandwich, MA
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
Index Map
Potential Roadway Sections & Features
Sagamore Twin
200-foot Buffer
N
1:20,000
0 500 1,000 2,000
Feet
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MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
SANDWICH ROAD
Plymouth, Bourne & Sandwich, MA
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
Index Map
Potential Roadway Sections & Features
Sandwich Road
200-foot Buffer
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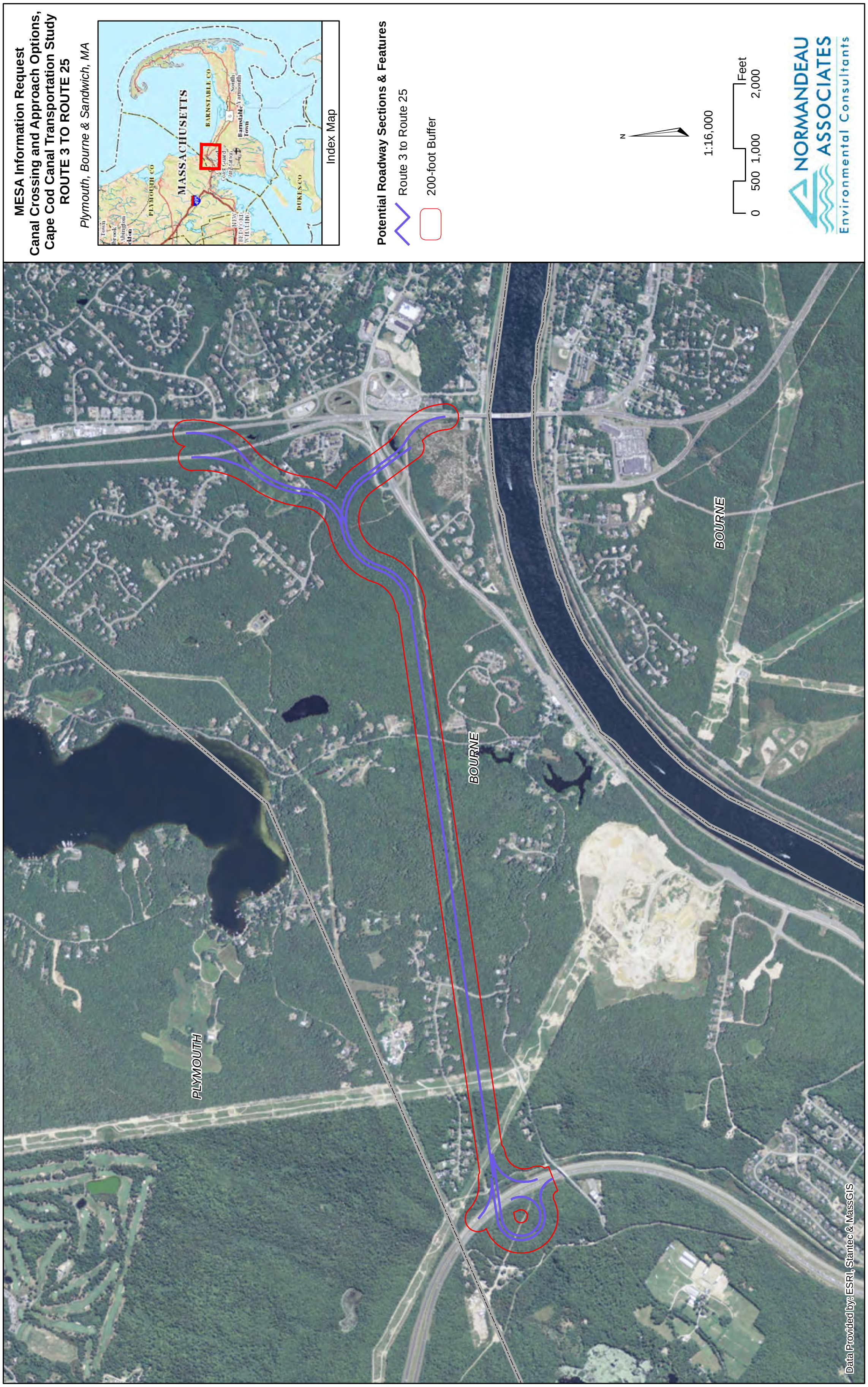


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MESA Information Request
Canal Crossing and Approach Options,
Cape Cod Canal Transportation Study
ROUTE 6 TO ROUTE 25 HOV
Plymouth, Bourne & Sandwich, MA
MASSACHUSETTS
PLYMOUTH CO
BARNSTABLE CO
DUKES CO
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Potential Roadway Sections & Features
Route 6 to Route 25 HOV
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**MESA Information Request**
**Canal Crossing and Approach Options, Cape Cod Canal Transportation Study**
**ROUTE 6 TO ROUTE 25 HOV SH Alt**

*Plymouth, Bourne & Sandwich, MA*


Index Map


**Potential Roadway Sections & Features**

Route 6 to Route 25 HOV SH Alt

200-foot Buffer

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# Appendix C:

# Cultural Resources Identification and Evaluation

Cultural Resources
Identification and Evaluation

Cape Cod Canal Transportation Study
Bourne, Sandwich and Plymouth, Massachusetts

Prepared for submission to:
The Massachusetts Department of Transportation

Prepared by:
Archaeological and Historical Services, Inc.

May 18, 2017

# ABSTRACT AND MANAGEMENT SUMMARY

The Cape Cod Canal Transportation Study is being conducted by the Massachusetts Department of Transportation (MassDOT). The purpose of the study is to develop and analyze potential improvement alternatives to the transportation system around the Cape Cod Canal, including possible new crossings of the canal and new highway, interchange, and non-highway improvements.

This report presents the results of the identification and evaluation of cultural resources that may be affected by the project. It was prepared by Archaeological and Historical Services, Inc. (AHS), under contract to Stantec, the engineering firm that is conducting the Study. For the purpose of this study, cultural resources are defined here as historic, archaeological and cultural/ethnographic resources. Historic resources include above-ground manmade resources such as buildings, structures, objects, districts, landscapes, and sites that meet the criteria for listing in the National Register of Historic Places (NRHP). Archaeological resources are buried pre-colonial Native American and historic-period sites. Cultural/ethnographic resources are above and below-ground areas of cultural sensitivity and importance to the Mashpee, Gay Head (Aquinnah) and Herring Pond tribes.

The Project Focus Area, located almost entirely in the town of Bourne, is rich in above-ground cultural resources. The Bourne Bridge and the Sagamore Bridge have already been identified by MHC as eligible for individual listing in the National Register of Historic Places (NRHP). The Cape Cod Canal itself and associated resources are considered potentially eligible as a National Register historic district. In the surrounding neighborhoods in Bourne, some buildings are individually listed in the NRHP, one has been determined by MHC as NRHP-eligible, and many others have been identified as potentially eligible for individual NRHP listing. Some Bourne neighborhoods have been identified as potential NRHP historic districts.

Several historic areas in Plymouth and Sandwich are also within and adjacent to the Project Focus Area. In Plymouth, one historic cemetery was identified in the Project Focus Area, potentially NRHP-eligible as part of a district. Several historic areas in Sandwich were identified in the vicinity of the proposed Route 6 lane addition extending to the Route 130 interchange, and the Route6A/Route 130 intersection. All the Sandwich resources are listed in the State Register of Historic Places and included in the Old King's Highway Regional Historic District; some are potentially NRHP-eligible as districts.

The Project Focus Area is also rich in archaeological and cultural resources. The river, marsh, and coastal resources available on the Cape made the area a prime place for Native American settlement for thousands of years. Villages were present, as evidenced by archaeological finds during the construction of the canal, and by oral tradition among the Wampanoag tribes. Archaeological surveys previously undertaken as part of cultural resource management projects in the Focus Area have identified dozens of archaeological sites. Areas of cultural importance to the Wampanoag tribes are present in numerous locations in the Project Focus Area.

In addition to archaeological sites associated with Native Americans, historic-period Euro-American sites are also likely present, due to the colonial settlement on the Cape in the early 17th century. As a result of the thousands of years of human habitation of Cape Cod, the potential for archaeological resources in undeveloped portions of the focus area is high, in even in residential lawn areas and areas that have been capped with gravel or asphalt, such as parking lots.

In summary, substantial modifications to the existing transportation systems related to the Cape Cod Canal will likely have potential direct and indirect adverse effects on a number of historic resources, including the canal itself, its bridges, and surrounding neighborhoods, as well as archaeological and cultural resources.

MassDOT is currently studying a number of alternatives to improve transportation over and around the Cape Cod Canal. The conclusions and recommendations presented in this document are subject to change as the designs progress and further work is undertaken to assist MassDOT and FTA in evaluating impacts to historic resources. The conclusions and recommendations are the opinion of the historic preservation consultant. Actual determinations of National Register eligibility and assessment of effects are properly part of the ongoing consultative process among FTA, MassDOT, and MHC, and will continue to develop as the project progresses.

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# 1.0 INTRODUCTION AND SCOPE OF WORK

## 1.1 INTRODUCTION

The Massachusetts Department of Transportation (MassDOT) is conducting the Cape Cod Canal Transportation Study to develop and analyze improvements to the transportation system around the Cape Cod Canal, including potential new crossings of the Canal and new highway, interchange, and non-highway improvements. MassDOT is reviewing a number of alternatives to improve transportation over and around the Cape Cod Canal (Figure 1, Appendix A). The study is at the preliminary, feasibility level, and the locations and design requirements of the alternatives are not sufficiently developed to precisely assess their potential direct effects on cultural resources. However, based on preliminary plans, evaluation of the potential effects of the alternatives is possible in a general sense.

The project is receiving state funding, thus requiring it to comply with the Massachusetts Environmental Policy Act (MEPA), which mandates consideration of possible effects to significant historic and archaeological resources. The project may eventually involve the U.S. Army Corps of Engineers (ACOE), which would require the project to comply with the National Environmental Policy Act (NEPA), Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800). These laws require consultation with the Massachusetts Historical Commission (MHC), regarding possible project-related effects to archaeological and historical resources eligible for listing in the National Register of Historic Places (NRHP).

This report presents the results of the identification of existing conditions with respect to cultural resources, inclusive of historic, archaeological, and cultural/ethnographic resources within the alternatives and within the Project Focus Area, roughly one mile north and south of the Canal (Figure 1, Appendix A). The report also presents an evaluation of potential effects of the various alternatives on historic, archaeological and cultural resources.

For the purposes of this report, historic resources are defined as above-ground cultural (i.e., standing) resources: buildings, structures, objects, districts, landscapes, and sites that meet or likely meet the criteria for listing in the NRHP. Archaeological resources are defined as below-ground pre-colonial Native American or historic-period sites. Cultural/ethnographic resources are defined as areas of significance identified by the Mashpee, Gay Head (Aquinnah) and Herring Pond Wampanoag tribes.

The report was prepared by Archaeological and Historical Services, Inc. (AHS) for Stantec, project engineers. This report is organized as follows: Section 2 presents the methodology used. Section 3 provides the historical background of the Project Focus Area. Section 4 discusses the existing conditions of the Cape Cod Canal and its three bridges. Section 5 addresses the existing conditions of the Project Focus Area's non-canal architecture and other historic resources. Section 6 presents existing conditions related to archaeological and cultural resources. Section 7 presents a preliminary evaluation of potential effects to historic resources. Section 8 presents an evaluation of potential effects to archaeological and cultural resources. Section 9 contains conclusions and recommendations.

## 1.2 SCOPE OF WORK

The scope of work is an assessment-level survey of existing conditions with respect to cultural resources, within the Project Focus Area, with specific reference to a variety of alignment alternatives presented by MassDOT. In addition, an assessment of potential effects of various alternatives was made. The study area for the Cape Cod Canal Transportation Study is the Project Focus Area, the area within a roughly one-mile radius of the Bourne Bridge, the Sagamore Bridge, and the roads that parallel the Cape Cod Canal between the bridges (Route 6/Scenic Highway to the north and Sandwich Road to the south) (Figure 1, Appendix A). The Project Focus Area is located almost entirely within the Town of Bourne, with a small portion in Plymouth. The Cape Cod Canal Transportation Study also includes road improvements outside of the Project Focus Area's one-mile radius in two locations: at Belmont Circle in Buzzards Bay, north of the Bourne Bridge; and at Route 6, south of Sagamore and to the 130 interchange. Two of the proposed alternatives (the Sagamore Twin and relocated Exit 1 options) also extend a short distance into the town of Sandwich.

The survey was conducted in accordance with *The Secretary of the Interior's Standards and Guidelines for Identification* and *The Secretary of the Interior's Standards and Guidelines for Evaluation* (1983 and ongoing revisions). AHS personnel inspected the Project Focus Area in May, July, September, and October 2016. A survey of the immediate vicinity of the canal was conducted on foot, resulting in field notes and about 500 photographs of historic properties. In addition to the walking survey, all public streets in the Project Focus Area were assessed in a windshield survey to identify additional historic properties that could be affected. Assessment of noise and vibration effects on National Register-listed or eligible resources will be deferred until information from those studies becomes available. Standing historic resources within and adjacent to the 200-foot buffer zone were identified in these areas.

AHS conducted background research to evaluate the potential for effects on historic resources in the Project Focus Area. A series of historic maps and views was assembled (see Appendices B and C), and existing National Register nomination forms were reviewed for individual properties and districts. AHS also reviewed survey information from the MHC's Massachusetts Cultural Resource Inventory System database (MACRIS) database. The research identified a significant number of standing historic resources in the Project Focus Area, including buildings, structures, sites, landscapes and objects.

In addition to consulting histories of the Cape Cod Canal, Bourne and adjacent towns, and of Cape Cod in general, AHS undertook additional background research to clarify the historic contexts for evaluating resources in the project vicinity. Sources included the collections of the Bourne Historical Society, the Bourne Archives, and the Cape Cod Canal Visitor Center and Museum, operated by the U.S. Army Corps of Engineers.

Additional research was conducted to collect data on recorded archaeological and cultural properties, and to assemble data sufficient to evaluate the archaeological sensitivity of an area (i.e., the potential of an area for containing significant, NRHP-eligible buried archaeological resources). The research also permitted the assessment of potential effects to known and possibly significant archaeological and cultural resources; recommending additional studies, if necessary, to identify specific archaeological sites rather than broader areas of archaeological sensitivity; and developing strategies for avoiding or mitigating effects to potential significant archaeological and cultural resources.

## 1.3 PROJECT PERSONNEL

Architectural Historian Marguerite Carnell Rodney conducted the historical background research and historic resource identification. She and Architectural Historian Stacey Vairo field-checked historic resources in the Focus Area and photographed them to document existing conditions. Together they also evaluated the historic resources for potential listing in the NRHP. Senior Archaeologist Sarah Sportman and Project Archaeologist Brianna Rae conducted the archaeological, historical, and environmental background research. Senior Archaeologist and GIS Specialist David Leslie prepared the figure graphics. AHS President Mary Harper served as project manager. Mary Harper and Senior Archaeologists Ross Harper and Sarah Sportman conducted Native American consultation.

# 2.0 METHODOLOGY

## 2.1 HISTORICAL RESOURCE RESEARCH

The scope of work included the identification and evaluation of standing (above-ground) historic resources, listed in or potentially eligible for listing in the NRHP, within the Project Focus Area and immediately adjacent to its borders. The study tasks included documentary research to identify historic properties and to establish an historic context to interpret the significance of canal- and non-canal-related historic resources. Site-specific resources included maps from the late 18th century to ca. 1937, Sanborn insurance maps from 1941-1959, and the Historic American Building Survey (HABS) documentation of Camp Edwards. AHS assembled a series of historic maps and images (see Appendices B and C) and reviewed existing National Register forms for individual properties and districts. Previous survey information from the MHC MACRIS database was also consulted, including review of inventory forms for individual resources, area inventories, and reconnaissance town reports.

In order to establish an overall historical context and help in the identification of historic resources, AHS consulted general Cape Cod and local published histories such as Freeman (1862) and Cumbler (2014). Additional research was undertaken to establish the historic contexts for evaluating resources in the project vicinity, including the records and photograph collections of the Bourne Historical Society and the Bourne Archives, as well as the Cape Cod Canal Visitor Center and Museum, operated by the U.S. Army Corps of Engineers.

## 2.2 ARCHAEOLOGICAL AND CULTURAL RESOURCE RESEARCH

The tasks of the archaeological assessment survey included researching the past environmental and historical development of the Project Focus Area and adjacent areas affected by design alternatives, and researching previously-documented archaeological resources in the vicinity of the Project Focus Area and alternatives. This included a review of historical maps to compile a capsule history of documented land use in the Project Focus Area, and to assess the potential of the Project Focus Area and alternatives to contain historic-period archaeological resources related to past use of the land. AHS also consulted with the federally-recognized Mashpee Wampanoag Tribe, Gay Head (Aquinnah) Wampanoag Tribe, and the Herring Pond Wampanoag Tribe about culturally sensitive areas that may be affected by the proposed improvements.

AHS researched the files of recorded archaeological sites and reports of past archaeological surveys conducted in the Project Focus Area on MACRIS and at the MHC. Relevant cultural resource management reports and archaeological publications were reviewed to help develop a pre-colonial Native American and historical context preparatory to assessing the potential for significant buried archaeological sites to be present in the Project Focus Area. Environmental sources on hydrology, geology, and soils were reviewed to establish an understanding of the natural environment that existed in the Project Focus Area prior to modern development, because these resources have known associations with pre-colonial Native American occupation.

# 2.3 EVALUATION OF SIGNIFICANCE

## 2.3.1 National Register of Historic Places Criteria

The criteria for listing in the National Register of Historic Places are generally used in historic and archaeological surveys as a bar metric for assessing the significance of historic, archaeological and cultural resources. Resources determined by the State Historic Preservation Office or a federal agency to be National Register-eligible are provided a measure of protection from federally funded or federally-permitted projects. Such resources are also accorded protection under Massachusetts Environmental Policy Act (MEPA).

Some historic resources within or adjacent to the Project Focus Area are already listed in the National Register of Historic Places (NRHP), or have been determined to be NRHP-eligible by MHC. Other resources identified by the project historians were evaluated for their potential eligibility for listing in the NRHP by applying the National Register criteria of significance, which state the following:

*The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:*

Criterion A *That are associated with events that have made a significant contribution to the broad patterns of our history; or*

Criterion B *That are associated with the lives of persons significant in our past; or*

Criterion C *That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*

Criterion D *That have yielded or may be likely to yield, information important in history or prehistory.*

Resources may qualify under one or more of the National Register eligibility criteria.

## 2.3.2 National Register of Historic Places Integrity

Historic properties were also evaluated for their integrity, which is the ability of a resource to visually convey its significance. The seven aspects of integrity are: location, design, setting, materials, workmanship, feeling, and association. The property must still possess several, if not most, aspects of the historical identity for which it is significant. The National Register defines these aspects of integrity as follows:

1. ***Location*** *is the place where the historic property was constructed or the place where the historic event occurred.*

2. ***Design*** *is the combination of elements that create the form, plan, space, structure, and style of a property.*
3. ***Setting*** *is the physical environment of a historic property.*
4. ***Materials*** *are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property.*
5. ***Workmanship*** *is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory.*
6. ***Feeling*** *is a property's expression of the aesthetic or historic sense of a particular period of time.*
7. ***Association*** *is the direct link between an important historic event or person and a historic property.*

### 2.3.3 State Register of Historic Places

Properties listed in the National Register of Historic Places are automatically listed in the Massachusetts State Register of Historic Places. Properties located in the Old King's Highway Regional Historic District are also automatically included in the State Register; see Section 5.5.1.

### 2.3.4 Other Criteria for Evaluation

For many known archaeological resources, and for areas of identified archaeological sensitivity (i.e., areas with high potential for containing intact archaeological sites), State or National Register-eligibility has not been determined. Such determination would require additional research beyond the scope of this feasibility-level study. However, there are areas and landscape features considered to have high cultural importance to Native American tribes; these areas and features may qualify for NRHP listing as Traditional Cultural Properties.

# 3.0 HISTORICAL BACKGROUND OF THE PROJECT FOCUS AREA

## 3.1 ENVIRONMENTAL CONTEXT AND ARCHAEOLOGICAL SENSITIVITY

Cape Cod is located in an ecoregion identified as the Cape Cod and Long Island Pine Barrens (Griffith et al. 2009). The topography in this ecoregion consists primarily of level to rolling plains, with some steeper slopes on moraines. Parts of the Cape are characterized by a "knob and kettle" topography, consisting of an undulating landscape with knolls or ridges of glacial debris interspersed with irregular depressions and pits that may contain swamps or ponds (Natural Resources Canada 2016). Coastal areas are defined by bays and inlets, dunes, beaches, tidal flats. Elevations are generally low, ranging from 0-150 feet above mean sea level (amsl).

The bedrock on the Cape is comprised of Precambrian granite, gneiss, and schist covered by 200-400 feet or more of gravel, sand, silt, and clay. The surficial geology, formed as a result of the Wisconsin glaciation (21,000 to 13,600 ya) is primarily comprised of quaternary outwash sand and gravel, and loose sandy till related to the kame moraine.

Cape Cod and the Islands are characterized by abundant natural resources. Cape Cod has over 350 ponds, 209 of which are classified as Great Ponds, because they are ten or more acres in area (MHC 1986). The vegetational patterns on the Cape and Islands are influenced by the proximity to the ocean, drainage, soil, and the history of human land use (MHC 1986). Vegetational zones include a mix of inland forests and woodlands, coastal forests, maritime woodlands, swamps and bogs, dunes, sandplain grass and heathlands, and salt marshes (Griffith et al 2009). These zones result in a range of microhabitats supporting a variety of plants, animals, birds, and fish. The region's rich and varied wild flora and fauna resource bases made Cape Cod attractive for pre-colonial Native American and later colonial and historic-period European settlement. As a result, most undeveloped portions of Cape Cod are considered to have high archaeological sensitivity for both pre-colonial and historic-period resources.

## 3.2 GROWTH AND DEVELOPMENT OF BOURNE

The town of Bourne was incorporated in 1884. It is the western-most town on Cape Cod and in Barnstable County, consisting of several villages formerly in the northwestern part of Sandwich (Maps 1-2, Appendix B). Bourne includes the following communities: Buzzard's Bay (previously Cohasset; Map 3), Bourne Village (previously Monument, Manomet; Map 4), Pocasset and Cataumet (previously North and South Pocasset, south of the Project Focus Area), Bournedale (previously North Sandwich, Herring River, Comassakumanit/Comassukumkanet, Maps 5-6), and Sagamore (previously West Sandwich, Scusset; Map 7) (Dimock 2013: 7).

The first European settlement in the Bourne area was established in 1627, by the Plymouth colony, for the purpose of trade. Known as Aptucxet, the trading post was located on the south side of the Manomet River, close to the shore of Buzzard's Bay. Settlements at Manomet and Pocasset soon followed. Missionaries such as Richard Bourne and Thomas Tupper worked to convert Native peoples to Christianity; a settlement of Christian Natives was founded in the area now known as Bournedale, where a meeting house was built for them south of Great Herring Pond. Economic activities during this early period including agriculture, livestock, fishing, shell-

fishing, and trade with Plymouth and settlements further east on Cape Cod. Later in the colonial period, these pursuits continued, and gristmills were built to process corn, oats, wheat, and rye. Cutting of wood and production of pine products (e.g. turpentine, pitch and tar) were other important sources of income (MHC 1984: 2-7).

By the early 19th century, small settlements had been established at Sagamore (Scusset), including an inn and a Methodist church. In the Bournedale area, a small textile mill and a factory that produced axes and triphammers were established. In Bourne Village (Monument), a Congregational church was built in 1794 and the settlement continued to grow. Other new communities were associated with a salt works north of Monument. Pocasset emerged as a local transportation center, and it also had ironworks. The majority of these villages were located along the coasts of Buzzard's Bay and Cape Cod Bay, while inland was primarily undeveloped woodland (Maps 1-2, Appendix B). In Sagamore, the Herring River provided power for small industries, including a woolen mill and a nail factory, both built in 1831. The nail factory was later turned into the Manomet Iron Works, a foundry. These economic pursuits flourished in concurrence with agriculture, wood cutting, and maritime activities (MHC 1984: 7-8) (Image 1, Appendix C).

In the mid- to late 19th century, transportation routes were expanded and new markets developed. The Cape Cod Branch Railroad was established in 1848, first running from Middleboro to the center of Sandwich. On the north side of the Monument River, the railroad's arrival fostered the growth of wharves and facilities to transport coal. The railroad also contributed to the cranberry industry in Bourne. The Woods Hole Branch Railroad began providing service in 1872, running from Buzzard's Bay through Bourne Village (Monument) south to Cataumet (MHC 1984: 8-13).

The late 19th to the early 20th century constituted the period of fastest growth in Bourne, mostly due to the railroad. By 1915 Bourne was the fourth largest town on the Cape (after Barnstable, Falmouth, and Provincetown). The railroad provided transportation for tourists, and hotels were erected near the railroad depot in the village of Buzzard's Bay, which began to develop into a commercial center (Images 2-3, Appendix C). Summer estate properties sprang up along the Buzzard's Bay coast and Buttermilk Bay. In Bourne Village and Buzzard's Bay, municipal buildings were constructed in this period, including the town hall, the library, and the high school (Images 4-5, Appendix C). In Sagamore, the Keith Manufacturing Company (founded in 1829 for blacksmithing and wheel production, later shifting to tools, carriages, stage coaches, schooners, and railroad cars) built a large factory (Image 6, Appendix C). Housing was also erected to accommodate its workforce. By 1910, Sagamore Beach to the north had a hotel and small collection of houses. Industry such as ironworks and tool production continued to flourish in Bourne, along with the emerging tourist economy (MHC Reconnaissance Survey Town Report 1984: 10-16) (Image 7, Appendix C).

## 3.3 CAPE COD CANAL

The Cape Cod Canal is located at an eight-mile isthmus separating Buzzard's Bay from the Cape Cod Bay. Before the canal, the isthmus was crossed by the Monument (Manomet) and Scusset rivers and Herring Brook. In order to avoid navigating around Cape Cod, Native populations would travel on the Manomet and Scusset rivers (about five miles were navigable) and portage their boats between the river valleys. Plans for a canal through the isthmus had been proposed in 1627 by William Bradford, Governor of Plymouth Colony, and possibly as early

as 1623 by Miles Standish, the colony's military leader. George Washington ordered the first survey of the area in 1776 (Map 8, Appendix B). A series of surveys was undertaken in the late 18th century and throughout the 19th century, and several canal building campaigns began and were subsequently abandoned (Orwig 2013: 7-8)(Map 9, Appendix B).

The successful completion of the canal was accomplished by August Perry Belmont (1853-1924), who purchased the Boston, Cape Cod and New York Canal Company. Led by engineer William Barclay Parsons (1859-1932), work began in 1909. The canal was constructed with dredges, steam shovels, and narrow-gauge railroad equipment (Images 8-11, Appendix C). It first opened in 1914 on a limited basis as a privately-owned toll waterway (Image 12, Appendix C). The original crossings comprised a ferry service for passengers in Bournedale, two highway drawbridges, and a railroad drawbridge. Dredging continued until 1916 to increase the canal depth to 25 feet (Orwig 2013: 7-8; MHC Area Form BOU.AF 2000: 6-14) (Map 10, Appendix B).

When German submarines threatened U.S. vessels off of Cape Cod during World War I, the federal government assumed jurisdiction and operation of the Cape Cod Canal in 1918, made improvements, and returned it to private ownership in 1920. The U.S. government purchased the canal in 1928 and the U.S. Army Corps of Engineers was tasked with its improvements and operation as a free waterway. During the Great Depression in the 1930s, the Corps undertook an extensive canal reconstruction, straightening the Buzzards Bay approach channel, widening and deepening the waterway, and replacing the bridges (Map 11, Appendix B; Image 13, Appendix C). The bridges were completed in 1935 and the canal work was finished in 1940. At 480 feet wide and 32 feet deep, the Cape Cod Canal was the widest sea-level canal worldwide (MHC Area Form BOU.AF 2000: 17-18).

## 3.4 CAPE COD CANAL BRIDGES

Before the canal was built, the Monument River had a wooden bridge built in 1824, which was replaced in 1892. The later bridge was removed in 1914. These bridges were located near Bridge Street, now known as Old Bridge Road in Buzzards Bay and Keene Street in Bourne Village.

The canal necessitated the construction of three new bridges and related railroads and roadways. During canal construction, the railroad was relocated and a new steel Strauss trunnion bascule railroad bridge was completed in 1910. The Bourne Highway Bridge (1911), included a streetcar sidetrack for the New Bedford & Onset Street Railway, which operated in Bourne 1901-1926 (Image 14, Appendix C). The north abutment of this bridge is still extant, west of the Bourne Bridge. The Sagamore Highway Bridge was completed in 1913, on the site of the Willow Dam on Swift Mill pond, which was drained when the canal was built (Image 15, Appendix C). The two highway bridges were steel, on concrete footings, with deck girders and truss spans that flanked Scherzer double-leaf rolling bascule bridges. Road improvements followed the bridge construction. In the 1920s, the new Route 3 was extended to reach Sagamore, and Route 6 was built through Buzzards Bay and Sagamore. Route 28 was an upgraded county road that led to Falmouth (MHC Area Form BOU.AF 2000:11).

The location of the 1934-1935 Cape Cod Canal highway bridges that accompanied U.S. Army Corps of Engineers' canal reconstruction had been a source of debate. The government had proposed a single new highway bridge mid-way along the canal. The single-bridge plan was rejected by local communities, however, and the new Bourne and Sagamore bridges were constructed close to the 1911 and 1913 drawbridges (MHC Area Form BOU.AF 2000:13). The

award-winning, nearly identical bridges were designed by Fay, Spofford, and Thorndike of Boston, in collaboration with architectural firm Cram and Ferguson (Images 16-19, Appendix C). Accompanying traffic circulation upgrades were upgraded four-lane highways, the rotaries, and the Route 6 Sagamore bypass (MHC Area Form BOU.AF 2000: 13-14).

The new Buzzards Bay Railroad Lift Bridge was located to the east of the 1910 railroad bridge (Image 20, Appendix C). It was designed by Parson, Klapp, Brinckerhoff and Douglas of New York, in collaboration with the architectural firm of McKim, Mead & White for the towers' decorative treatment. It was completed in 1935 (MHC Area Form BOU.AF 2000:14).

# 4.0 EXISTING CONDITIONS: CAPE COD CANAL AND BRIDGES

## 4.1 CAPE COD CANAL

The Cape Cod Canal (MHC ID BOU.AF, SDW.Z, and WRH.V), owned and operated by the U.S. Army Corp of Engineers, is located within the towns of Bourne, Sandwich, and Wareham (Figure 1, Appendix A; Photographs 1-4, Appendix D). The Cape Cod Canal and its approach channels are roughly 18 miles long, extending from the Cleveland Ledge Lighthouse in Buzzards Bay to the North Breakwater in Sandwich, on the Cape Cod Bay.

The land-cut canal section (visible above water) is about 8 miles long, extending from the Buzzards Bay village in the town of Bourne to the Cape Cod Bay in Sandwich. The canal is a man-made, sea-level waterway, with an average width of 540 feet at the water's surface that narrows to 480 feet at the bottom. There are access roads on both sides of the canal that are used for biking and pedestrian recreation. Three bridges span the canal: the Bourne Bridge, the Sagamore Bridge, and the Buzzards Bay Railroad Lift Bridge.

The MHC survey of the Cape Cod Canal identifies it as a district that is potentially eligible for the National Register of Historic Places (NRHP), consisting of 23 historic resources. Eighteen of the 23 retain a significant amount of historic integrity and would be contributing resources. The five non-contributing resources are located at the ends of the canal, outside of the Project Focus Area. The eastern end of the canal, and the land just north of it in Sandwich (but not in Bourne), is included in SDW.R (the Old King's Highway Regional Historic District) and is listed in the State Register. (See section 5.5.1 regarding the Old King's Highway Regional Historic District.)

## 4.2 BOURNE BRIDGE

The 1934 Bourne Bridge (BOU.919) carries a highway (Route 6W and Route 28) over the canal in Bourne, from the village of Buzzards Bay to Bourne Village (Figure 2, Appendix A; Photographs 5-6, Appendix D). The three-span bridge has a continuous swinging-type deck and through riveted steel Warren-type truss. Its overall length is 2,384 feet. The arched center span is 616 feet long, and the highway deck is suspended from the lower truss chords by steel wire cables. The center span is flanked by Warren deck truss spans that are each 396 long, as well as 2 additional approach spans on each side. The overall deck width is 487 feet. Vertical clearance under the bridge is 135 feet. The bridge has concrete open-web column piers and concrete abutments. The concrete piers feature Art Moderne stylistic elements. MHC has determined that the Bourne Bridge is individually eligible for the NRHP.

## 4.3 SAGAMORE BRIDGE

The 1935 Sagamore Bridge (BOU.918) is almost identical to the Bourne Bridge (Figure 2, Appendix A; Photographs 7-8, Appendix D). It carries Route 6 over the canal from North Sagamore to South Sagamore in the town of Bourne. The three-span bridge has a continuous swinging-type deck and through riveted steel Warren-type truss. Its overall length is 1,408 feet. The arched center span is 616 feet long, and the highway deck is suspended from the lower truss chords by

steel wire cables. The center span is flanked by Warren deck truss spans that are each 396 long supported by concrete abutments. The overall deck width is 487 feet. Vertical clearance under the bridge is 135 feet. The bridge’s concrete piers feature Art Moderne stylistic elements. MHC has determined that the Sagamore Bridge is individually eligible for the NRHP.

## 4.4 BUZZARDS BAY RAILROAD LIFT BRIDGE

The 1935 Buzzards Bay Railroad Lift Bridge (BOU.901) is a Waddell patent vertical lift bridge with Warren-type trusses (Figure 2, Appendix A; Photograph 9, Appendix D). It has two approach spans, two towers, and an arched center lift span is that 544 feet long; all are of riveted steel frame construction. The steel superstructure is supported by granite block substructure. The approach spans are each 128 feet long, with 4-panel X-braced through-trusses. The control booth is located on the east side. When the center span is lifted, the vertical clearance under the bridge is 135 feet. Each tower is surmounted by conical openwork pinnacles that rest on the bridge drive houses. The Buzzards Bay Railroad Lift Bridge is potentially eligible for individual listing in the NRHP. It is located just west of the Project Focus Area.

# 5.0 EXISTING CONDITIONS: NON-CANAL HISTORIC RESOURCES

## 5.1 NORTH OF CANAL: BOURNE

### 5.1.1 Head of the Bay & Surrounding Area

Head of the Bay (BOU.C) is a small MHC-inventoried area on the east side of Buttermilk Bay, north of the Cape Cod Canal, along Head of the Bay Road (Figure 2, Appendix A). There are 4 inventoried houses (BOU.28 through BOU.31) dating from the 1680s to ca. 1840 in a rural setting (Photograph 10, Appendix D). Further research will be necessary to determine this area's NRHP eligibility. It is located northwest of the Project Focus Area.

Just southeast of BOU.C, the ca. 1725 Gibbs House was identified in 1999 as a potential NRHP individually-eligible resource. Since that time, its integrity of setting has been compromised by a large new house built adjacent to it (Photograph 11, Appendix D).

The Head of the Bay Cemetery (BOU.803) is located south of BOU.C, on the west side of Head of the Bay Road, and within the Project Focus Area. It is a small cemetery, less than one acre and with about 25 grave markers, dating from 1885 to 1996 (Photograph 12, Appendix D).

#### 5.1.1.1 NRHP Potential Individually-Eligible Resources

- The ca. 1725 Gibbs House (BOU.60), 295 (formerly 291) Head of the Bay Road, is located south of BOU.C and is just north of the Project Focus Area.

Refer to Appendix E, Table 1.

### 5.1.2 Buzzards Bay Main Street & Surrounding Area

The Main Street Commercial Area (BOU.J) is located in the village of Buzzards Bay on the north side of the Cape Cod Canal (Figure 2, Appendix A). The Project Focus Area overlaps the east end of this inventoried area. BOU.J is about 35 acres in size, with architecture ranging from the late 19th to the early 20th centuries, including commercial and residential uses along Main Street. There is little landscaping and most buildings are sited close to the street. Infill buildings from the second half of the 20th century are located throughout the area, and many of the earlier buildings have been altered. Stylistically, the area includes several examples of the Gothic, Spanish, Classical, and Colonial Revivals, Art Deco, Craftsman Bungalows, but many of the commercial buildings and modest houses have no particular style. The Bourne Family Cemetery (BOU.804) is set back from Main Street behind a parking lot. It has about 12 grave markers dating from 1862 to the early 20th century. This area contains 20 inventoried resources.

According to the MHC survey, the eligibility of this area as a NRHP district appears to be low. The Buzzards Bay Railroad Station at the west end of the area is a potential NRHP individually-eligible resource (Photographs 13-14, Appendix D). The Bourne Town Hall, just south of the area

boundaries, is individually listed in the NRHP and the State Register (Image 5, Appendix C; Photograph 15, Appendix D).

The Mass. Army National Guard Armory (BOU.388), just north of the BOU.J boundary, has been determined by MHC to be individually NRHP-eligible (Figure 2, Appendix A; Photograph 16, Appendix D). The Abraham F. Swift House, also south of the area boundary, is potentially NRHP individually-eligible (Photograph 17, Appendix D). These resources are located within the Project Focus Area.

South of the district along the Cape Cod Canal, the First Bourne Bridge Abutment (BOU.940) and the Cape Cod Canal Electrical Substation (BOU.389), at the south end of Perry Avenue, are part of the Cape Cod Canal area (BOU.AF), potentially eligible as a NRHP district (Photographs 18-19, Appendix D). These resources are located with the Project Focus Area.

#### 5.1.2.1 NRHP-Listed Individual Resources

- Bourne Town Hall (BOU.AE; BOU.68), 24 Perry Ave. is just south of BOU.J.

#### 5.1.2.2 NRHP Individually Eligible Resources per MHC Opinion

- Mass. Army National Guard Armory (BOU.388)10 Armory Rd, just north of BOU.J.

#### 5.1.2.3 NRHP Potential Individually-Eligible Resources

- Buzzards Bay Railroad Station (BOU.65) and Tower (BOU.66) on Main Street at Academy Drive, just west of the project focus area.
- Abram Swift House (BOU.67), 37 Old Bridge Street, is located southeast of BOU.J adjacent to the Cape Cod Canal and within the Project Focus Area.

Refer to Appendix E, Table 1.

### 5.1.3 Bournedale & Surrounding Area

The Bournedale Area (BOU.I) is located on the north side of the Cape Cod Canal between the Bourne and Sagamore bridges (Figure 2, Appendix A). It lies entirely within the Project Focus Area. The inventoried area is about one mile in length, beginning at the south end at Route 6 (Scenic Highway) and extending north along Bournedale Road and Herring Pond Road. The resources in Bournedale include examples from the 17$^{th}$, 18$^{th}$, 19$^{th}$, and 20$^{th}$ centuries. The area is sparsely settled, with some late 20$^{th}$-century infill located mostly along residential side roads. The streets are lined with mature trees. The Bournedale area includes 16 inventoried resources.

The architecture of the Bournedale area is primarily residential, but includes several commercial buildings and a former school. This area includes examples of the Federal, Greek Revival, Gothic Revival, and Victorian Eclectic styles, as well as traditional “Cape Cod” houses with few stylistic details, and other buildings of no particular style from the 19$^{th}$ and early 20$^{th}$ centuries.

There are several important sites and structures in Bournedale. Burying Hill (BOU.920) on Herring Pond Road is a focal point as the site of the First Meeting House (non-extant) and Native

American burials (Photographs 20-21, Appendix D). This hill is one of the highest points north of the Cape Cod Canal. The Herring Run (BOU.921), at the west end of the Carter Beal Conservation Area located west of Bournedale Road (Photograph 22, Appendix D). Just outside the southwest corner of the Bournedale area is the 1936 Herring Run Fish Ladder (BOU.938), which runs along Route 6 east, adjacent to the Cape Cod Canal (Photograph 23, Appendix D). The Herring Run Fish Ladder is inventoried as part of the Cape Cod Canal area (BOU.AF), which is potentially eligible as a NRHP district.

Further research will be necessary to determine Bournedale's NRHP eligibility. The 1897 Village School is individually listed in the NRHP and the State Register (Figure 2, Appendix A; Photograph 24, Appendix D). Three properties are potential NRHP individually-eligible resources: the Wilson D. Bent, Sr. House, the Josiah Ellis House, and the Nathan Bourne Ellis House and Bournedale Lodge (Photographs 25-27, Appendix D). The Mason White/Battles House was previously identified as a potential NRHP individually-eligible resource, but its integrity has since been compromised by incompatible door and window replacement and vinyl siding (Photographs 28, Appendix D).

North of the Bournedale, within the Project Focus Area, is the Indian Cemetery (BOU.800) located on the south shore of Great Herring Pond (Photograph 29, Appendix D). The cemetery straddles the Bourne/Plymouth town line and is the same resource as Indian Cemetery (PLY.800). It comprises 16 grave markers, with the earliest marker dating to 1849, and likely includes earlier unmarked graves. The cemetery is still in use. It is potentially eligible for the NRHP as a contributing resource to the Cedarville Area in Plymouth (PLY.G). See Section 5.2.

#### 5.1.3.1 NRHP-Listed Individual Resources

- Bournedale Village School (BOU.57), 29 Herring Pond Rd.

#### 5.1.3.2 NRHP Potential Individually-Eligible Resources

- Wilson D. Bent, Sr. House (BOU.55) and garage (BOU.56), 9 Bournedale Rd.
- Josiah Ellis House (BOU.209) and barn (BOU.210), 166 Herring Pond Rd.
- Nathan Bourne Ellis House (BOU.211) and Bournedale Lodge (BOU.212, 213), 854 Route 6 (Scenic Highway).

Refer to Appendix E, Table 1.

### 5.1.4 North Sagamore

North Sagamore (BOU.O) is located on the north side of the Cape Cod Canal, east of the Sagamore Bridge, and entirely within the Project Focus Area (Figure 2, Appendix A). It is north of Savery Avenue (BOU.P), and south of Sagamore Beach (BOU.U). North Sagamore is about 90 acres in size, with architecture that ranges from the early 18th through the early 20th centuries, including houses and several garages, a school, and a church. Most are located along Old Plymouth, Williston, and Hunters Brook roads. North Sagamore's architecture includes traditional "Cape Cod" houses with few stylistic details as well as examples of the Greek Revival, Classical Revival, and Victorian Eclectic styles. BOU.O contains 13 inventoried resources; some historic resources in this area remain un-inventoried.

Further research would be necessary to determine this area's NRHP eligibility. Three properties within it are potential NRHP individually-eligible resources: the Swift Memorial Methodist Episcopal Church, the Sagamore Grammar School, and the Captain William Crowell Gibbs House (Image 21, Appendix C; Photographs 30-32, Appendix D).

#### 5.1.4.1 NRHP Potential Individually-Eligible Resources

- Swift Memorial Methodist Episcopal Church (BOU.118), 10 Williston Rd.
- Sagamore Grammar School (BOU.119), 30 Williston Rd.
- Captain William Crowell Gibbs House (BOU.281) and outbuildings (BOU.282, 282), 252 Old Plymouth Rd.

Refer to Appendix E, Table 1.

### 5.1.5 Savery Avenue

Savery Avenue (BOU.P) is located along the north side of the Cape Cod Canal, east of the Sagamore Bridge, and entirely within the Project Focus Area (Figure 2, Appendix A; Image 22, Appendix C; Photographs 33-34, Appendix D). It is just south of North Sagamore (BOU.P). The Savery Avenue area contains about 3 acres, with closely-spaced houses of 2 types (Dutch Colonial Revival and hipped-roof Four Squares) constructed ca. 1908-1909. It contains 15 inventoried resources. Further research would be necessary to determine this area's NRHP eligibility.

Refer to Appendix E, Table 1.

### 5.1.6 Sagamore Beach

Sagamore Beach (BOU.U) is an MHC-inventoried area located on Cape Cod Bay, on the north side of the Cape Cod Canal (Figure 2, Appendix A). It consists of about 100 acres, with residential properties ranging from the late 17$^{th}$ to the early 20$^{th}$ centuries; most date to the early 20$^{th}$ century. There are 13 inventoried resources and additional un-inventoried historic resources. Sagamore Beach is located just northeast of the Project Focus Area.

Further research would be necessary to determine this area's NRHP eligibility. Three of its inventoried properties, the Crowell Farm, Assembly Hall, and the Rev. William E. Wolcott House, are potential NRHP individually-eligible resources (Photographs 35-37, Appendix D).

#### 5.1.6.1 NRHP Potential Individually-Eligible Resources

- Crowell Farm (BOU.27), 31 Crowell Rd.
- Assembly Hall/Harold S. Clark Hall (BOU.175), 30 Robinson Rd.
- Rev. William E. Wolcott House, (BOU.323), 39 Robinson Rd.

Refer to Appendix E, Table 1.

## 5.2 NORTH OF CANAL: PLYMOUTH

### 5.2.1 Cedarville

The Project Focus Area includes a small area in Plymouth at the southern edge of Great Herring Pond. This area is part of Cedarville (PLY.G), an MHC-inventoried area on the east and south sides of the pond (Figure 2, Appendix A). It consists of residential and commercial properties ranging from ca. 1800 to the present along with a church and five cemeteries. Most of the houses are mid-19th century Greek Revival. Before European settlement, the area was a large Wampanoag settlement known as Comassukumkanet, and later as the Herring Pond Indian Reservation.

Within the Project Focus Area is the Indian Cemetery (PLY.800), the same resource as Indian Cemetery (BOU.800), located on the south shore of Great Herring Pond (Photograph 29, Appendix D). The cemetery straddles the Bourne/Plymouth town line. It comprises 16 grave markers, with the earliest marker dating to 1849, and likely includes earlier unmarked graves. The cemetery is still in use. It is potentially eligible for the NRHP as a contributing resource to the Cedarville Area (PLY.G). See Section 5.1.3.

Refer to Appendix E, Table 1.

## 5.3 NORTH OF CANAL: SANDWICH

### 5.3.1 Sagamore Hill Gun Battery

The Sagamore Hill Gun Battery (SDW.AA) is just east of the Project Focus Area on Cape Cod Bay, located within SDW.Z, the eastern end of the Cape Canal in the town of Sandwich (Figure 2, Appendix A). The Sagamore Hill Gun Battery area is about one acre in size, located at the top of Sagamore Hill in the Scusset Beach State Reservation (Photograph 38, Appendix D). It consists of two “Panama”-type gun mounts and two accompanying shelters. This installation dates to 1941-1942, constructed by the U.S. Army Corps of Engineers for the protection of the Cape Cod Canal during World War II. It is potentially eligible for the NRHP.

The Sagamore Hill Gun Battery is included in SDW.R (the Old King’s Highway Regional Historic District and is listed in the State Register. See section 5.5.1 regarding the Old King’s Highway Regional Historic District.

Refer to Appendix E, Table 1.

## 5.4 SOUTH OF CANAL: BOURNE

### 5.4.1 Keene Street – Sandwich Road

Keene Street – Sandwich Road Area (BOU.A) is located in Bourne Village, on the south side of the Cape Cod Canal and west of the Bourne Bridge (Figure 2, Appendix A). It lies entirely within the Project Focus Area. It is about 24 acres in size, with architecture that ranges from the late 17th to the early 20th centuries, including a mix of residential and institutional uses. The area extends

along Sandwich Road from the intersection of Perry Avenue and Sandwich, Trowbridge, Waterhouse, Cotuit, and Shore roads at the west end, to the intersection of Sandwich Road and Coastal Way at the eastern end. It also includes Keene Street, which is a loop road on the north side of Sandwich Road, adjacent to the Cape Cod Canal. The area includes 23 inventoried buildings.

The architecture of the Keene Street – Sandwich Road Area is primarily residential but also includes several institutional buildings. This area provides a remarkable view of Bourne Village's history, including buildings and structures from its inception as a settlement through the early 20th century, as Bourne was developing into a vacation destination. Architecture in this area includes the Federal, Greek Revival, Italianate, Victorian Eclectic, and Classical Revival styles, as well as traditional "Cape Cod" houses.

According to the MHC survey, the Keene Street – Sandwich Road Area is eligible for listing in the NRHP as a district. Three buildings are already listed in the NRHP and the State Register: the George I. Briggs House (BOU.1), the Jonathan Bourne Public Library (BOU.13, now the Jonathan Bourne Historical Center), and the Bourne High School (BOU.4, now the Waldorf School of Cape Cod) (Figure 2, Appendix A; Image 23, Appendix C; Photographs 39-41, Appendix D).

In the Keene Street – Sandwich Road Area (BOU.A), 6 properties in the Project Focus Area are potential NRHP individually-eligible resources: the Arabella Parker-George Ellis House, the Moses Waterhouse House, the Ordello Swift House, the Alonzo E. Booth Blacksmith Shop, the Jonathan Bourne Public Library (former Bourne Grammar School), and the Albert E. Eldridge House (Photographs 42-47, Appendix D).

East of BOU.A, also in the Project Focus Area, is the Deacon Gershom Ellis/Henry S. Blackwell House (BOU.50), previously identified as a potential NRHP individually-eligible resource. The integrity of the house has since been compromised by incompatible door and window replacement and vinyl siding (Photograph 48, Appendix D).

#### 5.4.1.1 NRHP-Listed Individual Resources

- George I. Briggs House (BOU.1), 22 Sandwich Rd.
- Jonathan Bourne Historical Center (former Jonathan Bourne Public Library) (BOU.13), 30 Keene St.
- Old Bourne High School (BOU.4), 86 Cotuit Rd.

#### 5.4.1.2 NRHP Potential Individually-Eligible Resources

- Arabella Parker-George Ellis House (BOU.49), 66 Sandwich Road
- Moses Waterhouse House (BOU.12 and barn (BOU.200), 59 Keene St.
- Ordello Swift House (BOU.45) and barn (BOU.46), 60 Keene St.
- Alonzo E. Booth Blacksmith Shop (BOU.48), 22 Sandwich Rd.
- Jonathan Bourne Public Library (former Bourne Grammar School) (BOU.14), 19 Sandwich Rd.
- Albert E. Eldridge House (BOU.10) and barn (202), 43 Sandwich Rd.

Refer to Appendix E, Table 1.

### 5.4.2 Shore Road North

Shore Road North Area (BOU.AH) is located in Bourne Village, just west of the Keene Street – Sandwich Road Area (BOU.A), on the south side of the Cape Cod Canal and west of the Bourne Bridge (Figure 2, Appendix A; Photographs 49-52, Appendix D). It lies entirely within the Project Focus Area. Much of its architecture dates from the19th and early 20th centuries and is primarily residential in use. The area extends west along Shore Road from the intersection of Perry Avenue and County Road. The area includes over a dozen inventoried resources, including the Oakland Grove Cemetery (BOU.802).

The architecture of the Shore Road North Area is primarily residential, with good examples of the Greek Revival, Italianate, Colonial Revival, and Craftsman styles. The MHC survey of this area is still in production and a full draft was not available to review for this report. Information will be updated as it becomes available. The NRHP eligibility of BOU.AH as a district has not been fully evaluated.

The Rev. Herman Perry House has been identified as a potential NRHP individually-eligible resource (Photograph 53, Appendix D).

#### 5.4.2.1 NRHP Potential Individually-Eligible Resources

- Rev. Herman Perry House (BOU.51), 7 Shore Rd.

Refer to Appendix E, Table 1.

### 5.4.3 Aptucxet Trading Post

The Aptucxet Trading Post Area (BOU.AG) is located in Bourne Village, west of the Keene Street – Sandwich Road Area (BOU.A), on the south shore of the Cape Cod Canal and west of the Bourne Bridge (Figure 2, Appendix A). It lies entirely within the Project Focus Area. The Aptucxet Trading Post building is a 1930 replica of the trading post established in 1627 by Plymouth Colony, representing the first European settlement in Bourne (Photograph 54, Appendix D). The current building was constructed on the foundation of the original trading post. The area contains 10 inventoried resources, including an outbuilding associated with saltworks.

The MHC survey of this area is still in production and a full draft was not available to review for this report. Information will be updated as it becomes available. This area is potentially eligible for listing in the NRHP as a district.

Refer to Appendix E, Table 1.

### 5.4.4 County Road North

County Road North Area (BOU.AJ) is located in Bourne Village, just west of the Keene Street – Sandwich Road Area (BOU.A), on the south side of the Cape Cod Canal and west of the Bourne Bridge (Figure 2, Appendix A; Photographs 55-57, Appendix D). It lies almost entirely within the Project Focus Area. Much of its architecture dates from the19th and 20th centuries and is primarily residential. The area extends south along County Road from the intersection of Shore Road and

Trowbridge Road. The area includes over three dozen inventoried resources, including the Oakland Grove Cemetery (BOU.801).

The MHC survey of this area is still in production and a full draft was not available to review for this report. Information will be updated as it becomes available. The NRHP eligibility of BOU.AJ as a district has not been evaluated.

The Deacon Elijah Perry House (BOU.43 and barn (BOU.44) have been identified as a potential NRHP individually-eligible resource (Photograph 57, Appendix D).

#### 5.4.4.1 NRHP Potential Individually-Eligible Resources

- Deacon Elijah Perry House (BOU.43) and barn (BOU.44), 203 County Rd.

Refer to Appendix E, Table 1.

### 5.4.5 Cape Cod Air Station – Otis Air Force Base

Cape Cod Air Station – Otis Air Force Base (BOU.B), sometimes also referred to the Camp Edwards, is now known as the Joint Base of Cape Cod (JBCC) (Figure 2, Appendix A). It serves as the base for several military commands training for missions in the USA and international missions. The base has about 22,000 acres on the south side of the Cape Cod Canal. The northern 15,000 acres are largely undeveloped (the largest undeveloped parcel on Cape Cod) and is used for soldiers' training. Within this area, there are several inventoried resources (BOU.351 through BOU.358) associated with the Cape Cod Air Station's PACE PAWS radar station, located on Flatrock Hill. These buildings and structures were constructed 1978 to 1985, of insufficient age to be NRHP-eligible. Many Camp Edwards resources have been documented by the Historic American Buildings Survey (HABS) program. Further research would be necessary to determine this area's NRHP eligibility.

No inventoried resources in the Cape Cod Air Station – Otis Air Force Base area are within, or adjacent to, the Project Focus Area or the proposed Route 6 lane addition.

Refer to Appendix E, Table 1.

### 5.4.6 South Sagamore

South Sagamore (BOU.V) is located on the east side of the Sagamore Bridge and is separated from North Sagamore by the Cape Cod Canal (Figure 2, Appendix A). It is located entirely within the Project Focus Area. South Sagamore is about 55 acres in size, with architecture ranging from the 18$^{th}$ through the early 20$^{th}$ centuries, including a mix of residential and commercial buildings as well as a church. It is a linear area with most resources located along Sandwich Road, with several on Pleasant and Burgess streets. Stylistically, the area has examples of the Federal, Greek Revival, Italianate, Victorian Eclectic, Queen Anne, Shingle, Colonial Revival, and Craftsman styles, as well as a number of buildings of no particular style. The South Sagamore area contains 41 inventoried resources, including houses, four apartment buildings, a cemetery, and three stone road markers. The cemetery is about seven acres, with roughly 500 grave markers dated from1803 to the present day.

South Sagamore's eligibility for listing in the NRHP as a district appears to be high. In the South Sagamore Area (BOU.V), eight properties are potential NRHP individually-eligible resources: the Burgess Homestead, the Isaac N. Keith House, the Old Gurney Store, the S. Harlow/Benjamin Harlow Pope House, the Crowell/Hannah Rebecca Burgess House, the C. G. Ellis House, the Rogers House, and the Freeman Farm Foreman's House (Photographs 58-65, Appendix D).

There are numerous historic buildings within the surveyed area that remain un-inventoried; a cursory walking survey identified over 30 additional buildings. In addition, side streets outside of the surveyed area such as Adams, Commonwealth, and Westdale streets include many un-inventoried late 19th to early 20th-century buildings that, although modest, retain historic integrity. The walking survey identified close to 20 such buildings (Photographs 66-69, Appendix D).

#### 5.4.6.1 NRHP Potential Individually-Eligible Resources

- Burgess Homestead (BOU.177), 11 Burgess St.
- Keith House (BOU.184) and garage (BOU.185), 66 Pleasant St.
- Old Gurney Store (BOU.186), 896 Sandwich Rd.
- S. Harlow/Benjamin Harlow Pope House (BOU.188), 941 Sandwich Rd.
- Crowell/Hannah Rebecca Burgess House (BOU.192) and barn (BOU.193), 1005 Sandwich Rd.
- C. G. Ellis House (BOU.344), 1071 Sandwich Rd.
- Rogers House (BOU.345), 1085 Sandwich Rd.
- Freeman Farm Foreman's House (BOU.194) and barn (BOU.195), 1101 Sandwich Rd.

Refer to Appendix E, Table 1.

## 5.5 SOUTH OF CANAL: SANDWICH

### 5.5.1 Old Kings Highway Regional Historic District

This regional district, which includes the area north of Route 6 in the towns of Sandwich, Barnstable, Yarmouth, Dennis, Brewster, and Orleans, was established in 1973. It is the largest historic district in the United States. Its purpose is to "promote the general welfare of the inhabitants of the applicable regional member towns so included, through the promotion of the educational, cultural, economic, aesthetic and literary significance through the preservation and protection of buildings, setting and places within the boundaries of the regional district and through the development and maintenance of appropriate settings and the exterior appearance of such buildings and places, so as to preserve and maintain such regional district as a contemporary landmark compatible with the historic, cultural, literary and aesthetic tradition of Barnstable County, as it existed in the early days of Cape Cod, and through the promotion of its heritage" (Old King's Highway 2008: 3).

The district is administered by the Old King's Highway Historic District Commission of six members, who also serve as chairmen of the six member towns' Historic District Committees. Within the district, new buildings, structures, or parts thereof must receive a certificate of appropriateness or certificate of exemption issued by the town's Historic District Committees. No building, structure,

or part thereof may be demolished or removed until an application has been filed with the Historic District Committee and a certificate for demolition has been filed with the town. Signs and billboards are also regulated (Old King's Highway 2008: 5-8).

The Sandwich section of this regional historic district is area is included in the MHC inventory as SDW.R (Figure 2, Appendix A). It is located within the Project Study Area but outside the Project Focus Area. The proposed relocated Exit 1 is adjacent to the west end of this district. All SDW.R resources are listed in the State Register (SR). Resources in the Old King's Highway Regional Historic District that are located within or adjacent to the Project Focus Area are discussed in sections 4.1, 5.3.1, and 5.5.2 to 5.4.4.

Refer to Appendix E, Table 1.

### 5.5.2 Shawme Road

The Shawme Road Area (SDW.F) is located outside the Project Focus Area, just north of Route 6, on the west side of the highway's interchange with Route 130 (Figure 2, Appendix A). It is a small inventoried area consisting of a ca. 1900 summer colony, with 5 inventoried houses, several outbuildings, and an open-air theater (Photograph 70, Appendix D). It is a good example of the many summer colonies built on Cape Cod in the late 19th and early 20th centuries, and it is the only such colony in Sandwich.

According to the MHC survey, the Shawme Road Area is eligible for listing in the NRHP as a district. It is located in the Old Kings Highway Regional Historic District (SDW.R). All resources in this local district are listed in the State Register.

East of the Shawme Road Area are two bridges (SDW.906 and 907) that carry Route 6 over Route 130 (Photograph 71, Appendix D). They are located in the Old King's Highway Regional Historic District (SDW.R) and are listed in the State Register. They would likely be affected by work at this interchange.

Refer to Appendix E, Table 1.

### 5.5.3 Route 6A West

The Route 6A West Area (SDW.G) is a section of the road that was built in the 1930s as a bypass to Main Street/Route 130 (Figure 2, Appendix A). It is located within the Project Study Area but outside the Project Focus Area. This inventoried area is a modern suburban landscape, with motor courts and other commercial buildings with paved parking lots, along with houses and lawns (Photographs 72-73, Appendix D). All buildings were constructed in the 20th century, and most date to after World War II. It also contains the Saddle and Pillion Burial Ground (SDW.802), a small late 17th-century cemetery (Photograph 74 Appendix D). The proposed relocated Exit 1 is adjacent to the west end of this inventoried area, close to this cemetery and a collection of 20th-century motor courts and houses.

According to the MHC survey, the eligibility of this area as a NRHP district appears to be low. It is located in the Old King's Highway Regional Historic District (SDW.R). All resources in this local district are listed in the State Register.

Refer to Appendix E, Table 1.

### 5.5.4 Main Street – Route 130

The Main Street – Route 130 Area (SDW.I) is a section of road that traverses the original Old King's Highway route (Figure 2, Appendix A). It is located within the Project Study Area but outside the Project Focus Area. Most of the buildings in this area are 20th-century houses, representing the trend toward suburbanization after World War II (Photographs 75-76, Appendix D). It also includes a number of 17th, 18th, and 19th-century buildings, along with two cemeteries. The proposed relocated Exit 1 is adjacent to the west end of this inventoried area.

According to the MHC survey, the eligibility of this entire area as a NRHP district appears to be low, but a small portion at its east end might be eligible as boundary increase of the NRHP-listed Town Center Historic District. This area is located in the Old King's Highway Regional Historic District (SDW.R). All resources in this local district are listed in the State Register.

Refer to Appendix E, Table 1.

# 6.0 EXISTING CONDITIONS: ARCHAEOLOGICAL AND CULTURAL RESOURCES

## 6.1 PRE-COLONIAL ARCHAEOLOGICAL RESOURCES

The Cape Cod Canal is a 17.5-mile-long artificial water passage that connects Buzzards Bay to the west and Cape Cod Bay to the east. The canal lies mainly within the limits of the town of Bourne, though a small eastern portion falls within the town of Sandwich. Initially constructed between 1910 and 1914 by August Belmont, the canal widened and conjoined the path of two previously disconnected rivers, the Manomet (or Monumet) and the Scusset (Davin and Herbster 1994:102). The Manomet River originally ran from the extant Great Herring Pond to Buzzards Bay, while the Scusset was a tidal river surrounded by a saltwater marsh system (Figures 3a and 3b).

Due to the canal's location, there is a high probability that intact areas surrounding the present channel contain pre-colonial archaeological resources. This includes the yard areas of existing houses and other structures, as well as areas that may simply be capped with asphalt or gravel, such as parking lots. The Project Focus Area encompasses different environmental settings that would have been attractive for food procurement, habitation, transportation, water sources, or burial grounds. In addition to the rivers that once flowed through this area, there are several freshwater ponds including Bourne Pond, Great Herring Pond, Nightingale Pond, Foundry Pond, Goat Pasture Pond, Black Pond, Great Pond, and Horse Pond. Kettle ponds would have been a vital resource from the earliest days of human settlement on the Cape, but seem to have been especially attractive during the Middle Archaic Period (Herbster and Laskoski 2011:34). The current marsh systems at both mouths of the canal would also have provided important resources once sea levels stabilized, beginning around 3,000 B.P.

To date, there are over 30 documented pre-colonial archaeological sites within the Project Focus Area, as well as an additional 23 sites located along proposed alternatives that extend beyond the Project Focus Area (Figure 4, Appendix A; Table 10, Appendix E). Identified sites date from the Middle Archaic through Contact period and there are also several sites without diagnostic materials or features that cannot be assigned to a particular period.

### 6.1.1 Identified Pre-Colonial Sites

A number of sites were identified along the canal in the first half of the 20th century. In 1911, the Grove Field Ossuary site (19-BN-612) was accidentally discovered by Frederick F. Bumpus while digging a cesspool. This probable Late Woodland site was located just south of Bourne Pond, on the north side of the canal and about 2000 feet west of the Bourne Bridge and Connections option (Figure 4). The portion of the ossuary that was excavated contained a mixture of cremated and non-cremated remains of at least 15 individuals in a shallow trench. No artifacts were recovered from the investigation; the remains appeared haphazardly arranged, and the ossuary is believed to be the result of a massacre or an epidemic (Bradley 1989).

Further west, and on the opposite side of the canal, an inscribed stone slab called the Aptucxet Petroglyph (19-BN-218) was documented in 1939 by E.B. Delabarre (MHC Site Form 19-BN-218,

1967). According to Delabarre, the stone served as the doorstop at an Indian meeting house in 1658, with “pictographs made by Indians at that time or later.” At the time of the report, the stone was being curated at the Aptucxet Trading Post. The trading post area, which is discussed in greater detail below, is located approximately 4300 feet west of the Bourne Bridge and Connections option (Figure 4).

In the 1940s, local avocational archaeologist Jesse Brewer documented several sites in the area surrounding the canal. In 1940, Brewer reported the destruction of a shell midden (19-BN-225) located on the north bank of the canal, between the Sagamore Bridge and the western edge of Scusset Beach State Park, about 2000 feet east of the Sagamore Twin option (Figure 4). In 1942, he recovered sherds from a large castellated Native pot along the northern bank of the canal where the Herring River now empties into the canal (Brewer 1961). The sherds were reassembled into an almost complete pot that is now housed in the Wampanoag Collection of Plimouth Plantation (Plimouth Plantation 2016). The pot is thought to be residual evidence of a Late Woodland/Contact village site (19-BN-224) destroyed by canal and road construction. Site 19-BN-224 is located along the path of the Scenic Highway option (Figure 4). In 1947, Brewer, along with William Whiting, excavated a rock shelter (19-PL-345), known as the Wampsett Rock site, on the Bourne/Plymouth line, located north of Goat Pasture Pond in the vicinity of Route 25 (Davin and Herbster 1994: 45). This rockshelter site did not produce diagnostic materials indicative of a particular time period, but excavations yielded several pre-colonial artifacts, including dozens of flakes and a possible hearth feature (the feature was not radiocarbon-dated). This site is located at the northern extent of the Project Focus Area along the Middle Bridge 1 option.

In 1977, an archaeological survey conducted prior to the construction of Route 25 located the Nightingale Site (19-BN-244), a pre-colonial site found west of Nightingale Pond and immediately northeast of the Bourne Bridge (Mueller et al. 1977), just west of the Bourne Bridge and Connections option (Figure 4). Artifacts included quartz debitage and a quartz biface fragment. The site has since been destroyed by a gas pipeline (Mueller et al. 1977). Another survey was conducted to the east of Nightingale Pond in 1977 by the Public Archaeology Laboratory, Inc. (PAL) for a proposed land development project (Mowchan and Gallagher 1988). Excavations produced two small loci of artifacts—one represented by two quartz flakes, and the other by a possible hearth feature. The lithic artifacts appeared to be isolated and were not considered significant enough for further testing, and the hearth was also not recommended for further testing because it could be avoided by construction.

A 1982 archaeological survey for the Route 25 alignment project identified several areas of pre-colonial artifact concentrations (Cheney 1982). The sites are located between Goat Pasture Pond and Horse Pond, east of Bourne Road and along the current path of Route 25. Valley Road, a former native trail that connected Great Herring Pond to Buttermilk Bay, runs through the survey area. Site 1 (19-BN-821) was identified based on a test pit with a quartz flake and charcoal fragments. Site 2 was located northeast of Wampsett Rock, which is the rockshelter site 19-PL-345 discussed above. The site contained 13 quartz flakes from two test pits adjacent to the rock, and additional test pits within the rock shelter displayed disturbance from the 1947 excavations. Site 3 contained two possible hearth features with fire-cracked rock but no further artifacts. In addition, three other areas that were collected by local residents clustered immediately south of these sites, and produced a variety of projectile points, most commonly small-stemmed quartz points.

A series of sites was located during a 1991 survey for a proposed wastewater treatment plant at the Otis Air Force Base in Bourne and Sandwich (Macomber 1991) (Figure 4). Most of the sites were found within a half-mile of the southern bank of the canal, between the Bourne and Sagamore bridges. The closest site to the canal's edge was located only about 150 meters south of the canal, directly across from Foundry Pond on the northern side. This site (19-BN-654) reflects an isolated quartz small stemmed projectile point base that was recovered from the topsoil in a test pit. An isolated quartz biface preform (19-BN-651) was found on the surface at the edge of a dirt access road on a power line right-of-way just northeast of Donnely Pond. Site 19-BN-655 consisted of an isolated surface find of a quartz small stemmed projectile point on a sloping edge of a dirt power line access road, about seven kilometers from the banks of the canal. About a mile northeast of this site, another isolated quartz small stemmed projectile point (19-BN-650) was recovered in the same manner. An isolated piece of quartz debris (19-BN-653) was found in the B horizon of a test pit just north of Discovery Hill. Less than a kilometer northeast, an isolated quartz small stemmed projectile point fragment (19-BN-656) was found on the ground surface. All of these sites represent isolated finds, and were not considered to be archaeologically significant at the time of survey. However, based on the number of identified sites and cultural materials, the Mashpee Wampanoag consider this portion of the base to have high cultural sensitivity (Figure 5; Ramona Peters, personal communication, September 2016).

In 1994, a PAL survey for a proposed gas pipeline located the Ridge Site (19-BN-685) in Bourne. The site was found on a ridge about 500 feet west of the Herring River, west of the terminus of Harding Lane (Figure 4). This location also abuts the eastern edge of the Carter Beale Conservation Area. The site contained six rhyolite flakes from a test pit and an array. The flakes were found within the first 30 centimeters of the test pits, which includes the upper B horizon. The site is described as a small upland temporary campsite or habitation site.

Also in 1994, PAL conducted an archaeological reconnaissance/inventory survey along the canal for the U.S. Army Corps of Engineers (Davin and Herbster 1994). The purpose of the survey was to locate areas of archaeological sensitivity to inform future construction plans. Several areas were considered to have low archaeological sensitivity due to prior disturbance. At the Buzzards Bay entrance to the canal, PAL ruled out the Rocky Point and Stony Point Dikes because both areas were artificially constructed to maintain the canal passage. The Army Corps Canal Field Office, located west of the railroad bridge on the north side of the canal, was found to be too developed to warrant testing. All of the bridges that traverse the canal—including the Bourne, Sagamore, and Railroad—were found to have disturbance in the areas below and adjacent to the structures. At the eastern mouth of the canal, the East Boat Basin was found to be heavily paved and developed.

Several areas were determined to have moderate to high archaeological sensitivity, resulting in further walkover assessment and subsurface testing. A total of 337 test pits were dug in nine areas along the canal (Davin and Herbster 1994). At Sagamore Hill, which is located in Sandwich at the eastern end of the canal within Scusset Beach State Reservation, two different loci of pre-colonial activity were located in undisturbed contexts. Sagamore Hill Locus 1 represents three flakes from two test pits on the hilltop, while Locus 2 represents eight flakes from seven test pits southeast of the hill, adjacent to wetlands. These loci were designated site 19-BN-687. This site, along with a village site identified immediately to the north (19-BN-227), fall just outside the Project Focus Area.

PAL also tested a linear transect between Route 6 and Canal Access Road on the north side of the canal in Bourne, immediately west of where the Herring River drains into the canal. The area

is considered highly sensitive due to the proximity of the Herring Run as well as site 19-BN-224 (Figure 4), which was found in the same area along the banks of the canal. In addition, U.S. Army Corps construction in this area in 1984 uncovered flakes and fragments of grit-tempered, decorated aboriginal ceramics. PAL's survey produced a total of 44 artifacts from nine test pits at depths of 0-70 cmbs. One of the test pits produced the highest density of pre-colonial materials from the entire canal survey, and also contained a possible feature. Another test pit produced a diagnostic Late Woodland Levanna projectile point. The site (19-BN-690), which was ultimately found to extend about 130 meters within the linear testing area, is likely a slice of a larger Late Woodland/Contact site that includes the artifacts previously discovered. These two sites are located within the path of the Scenic Highway option (Figure 4).

At the Midway Recreation Center in Bourne, PAL excavated 49 test pits within a 150-acre-area. Although a large portion of the area consisted of a gravel pit, the remaining intact area was thought to be archaeologically sensitive due to the proximity of the five findspot sites from the 1991 survey of the adjacent property (Macomber 1991). While PAL's excavations revealed natural soil profiles, no cultural materials were recovered.

PAL also surveyed two areas situated on either side of the canal to the east of the Bourne Bridge, about a half mile south of the Nightingale Site (19-BN-244) and Nightingale Pond. At the Bourne Recreation Area, which is located on the south side, PAL excavated 89 sterile test pits (i.e., contained no artifacts). Some of the test pits contained intact soils, while others were disturbed. On the north side, 26 sterile test pits were excavated at Bourne Scenic Park, most of which exhibited layers of fill over intact soils. A mile west of this area, PAL tested the Bourne Pond project area, a grassy strip paralleling the canal between Canal Service Road and residential housing. A transect of 28 test pits produced 26 flakes from seven pits, many of which exhibited disturbed soils. This since-named Bourne Pond-Canal Locus (19-BN-689) is within the vicinity of several archaeological sites, including the Grove Field Ossuary site (19-BN-612) and the Canal Place 1 and 2 sites (19-BN-886, 19-BN-887) (Figure 3). The site form also notes that residents of the immediate area have collected artifacts from their property that range in age from the Middle Archaic to Contact periods. The presence of these sites suggests that undisturbed areas in the westernmost portion of the Bourne Bridge and Connections option on the north side of the canal is highly sensitive for archaeological resources (Figure 4).

In the same survey, seven test pits were excavated at the Aptucxet Trading Post area, which is located west of the Bourne Bridge near the southern banks of the canal. The test pits contained intact soils and a small number of historic artifacts. The area was considered to be sensitive due to the high amount of cultural material found on the property. The Aptucxet Trading Post itself is a known historical site (BOU.5; discussed in greater detail below), and two other pre-colonial sites—the Hammond Site (19-BN-787) and the Cattail Site (19-BN-788)—have also been identified (Figure 4). The Hammond Site, which was excavated in the 1990s by Barbara Luedtke's field schools, produced over 140 flakes, four utilized flakes, one pestle fragment, an Onondaga chert Jack's Reef Pentagonal point, and a quartz point that is either a Jack's Reef Pentagonal or Fox Creek, as well as a Native American storage pit feature. Northwest of this area, adjacent to a small wetland, excavations at the Cattail Site produced over 300 flakes, two quartz cores, and one quartz biface or possible preform fragment in undisturbed soils. The trading post and adjacent sites are located in the southwest corner of the focus area and will not be directly impacted by any of the proposed options.

A 2003 University of Massachusetts Amherst survey of the Bourne and Sagamore rotaries identified an isolated quartz flake in a test pit. While no additional artifacts were found, the

authors surmised that the flake may be related to the series of sites located south of the Great Herring Pond, and the site was designated 19-BN-870 (Figure 4).

In 2005, PAL conducted a survey for a proposed housing development along the north side of the canal in Bourne, just west of Bourne Pond (Herbster and Millard 2005). Two sites were identified. Canal Place I (19-BN-886) produced a rhyolite Levanna projectile point, unidentified stone tool, 29 flakes, and a shell fragment. All of the artifacts were recovered from the plow zone except for one flake, which was found in intact subsoil. At Canal Place 2 (19-BN-887), a total of four flakes were found within the plowzone (Figure 4).

In 2007, PAL conducted a survey for improvements to Route 6 in Bourne, MA, on the north side of the canal, east of the intersection between Edgehill Road and Route 6 (Graves and Herbster 2007). About one-half-mile to the east is Foundry Pond and the outlet of Herring River into the canal. No artifacts were recovered from the excavation of 20 test pits. However, several artifacts were identified on the ground surface by Wampanoag Tribe of Gay Head/Aquinnah Tribal Historic Preservation Office members during the monitoring of construction. Artifacts included two rhyolite Levanna projectile points, as well as an unspecified number of flakes and bifaces.

A 2011 PAL survey for an NSTAR pole replacement project identified several areas with pre-colonial artifacts (Herbster and Laskoski 2011). The area with the highest artifact density was located at Pole 5, an area about 1.5 kilometers from the southern banks of the canal and west of the canal power plant. The site is bordered by a wetland to the east. Soil profiles indicated one or multiple layers of fill overlying a truncated plowzone and intact subsoils. At Pole 5, 37 of the 60 test pits contained cultural material, amounting to 1405 pre-colonial artifacts from both the plow zone and natural B subsoil. This included two Levanna projectile points, a Brewerton point, four untyped points, over 500 flakes, quartz bifaces, a steatite bowl fragment, aboriginal ceramic fragments, lithic cores, a drill, shell, charcoal, and calcined bone. At adjacent Pole 6, which is just east of 6A, 11 test pits were excavated, two of which contained a total of three flakes. To identify site boundaries, transects were placed between the Pole 5 and Pole 6, and between Pole 5 and the adjacent wetland. Between Poles 5 and 6, 15 of the 35 test pits produced a total of 387 flakes, three quartz projectile points, three bifaces, one quartz core, one calcined bone, and a shell fragment. Between Pole 5 and the wetland, 11 of the 15 test pits produced a total of 207 flakes, a quartz Levanna point, three bifaces, a groundstone fragment, and two shell fragments. Ultimately, the site extended from Pole 6 to about 40 meters east of Pole 5, where the wetland prevented any further testing. Due to evidence of site use from approximately 6,000 to 450 B.P., and the existence of previously identified findspots in the area, PAL recommended the site as eligible for listing in the NRHP.

### 6.1.2 Pre-colonial Archaeological Sensitivity

Despite the fact that the Project Focus Area surrounding the Cape Cod Canal includes small neighborhoods, major roadways, a rail line, and an artificially created waterway, there are many pockets of undeveloped and apparently undisturbed land, and these areas are likely to contain archaeological resources. Thus far, a combination of scattered professional testing and avocational collecting activities have revealed evidence of human occupation and activity in this area that ranges from the Middle Archaic Period to the present. While many sites have been officially recorded throughout the past century, there are likely numerous private collections with artifacts from this area as well. Overall, it is likely that cultural materials are broadly spread throughout the entire Project Study Area. As such, any area that is not already developed or

disturbed must be considered as potentially containing pre-colonial sites. These areas include clearly undeveloped parcels, as well as the yard areas of existing structures and any areas that may simply have been capped by asphalt, gravel or fill.

## 6.2 HISTORIC-PERIOD ARCHAEOLOGICAL RESOURCES

### 6.2.1 Identified Historic-Period Sites

Research in the files of MHC and the MACRIS database indicate that there are a total of seven documented historic-period archaeological sites in the focus area (Figure 4). These sites include three historic residential sites, two large boulders, and the Aptucxet Trading Post. The Herring Pond Wampanoag Burial Ground (BOU.800) does not have an archaeological site number, but should also be considered in an evaluation of historic-period archaeological sites.

Site BOU.1, the Gas House Site, is located in the Nightingale Pond conservation area, situated east of Route 25 as it approaches the Bourne Bridge. The site, which sits on a low, flat area on the west bank of Nightingale Pond, consists of the remains of a late 18th- to mid-late 19th-century house. The structure was identified during an archaeological survey conducted in 1976 as part of the Routes 25 and 28 Environmental Impact Statement. The survey identified the corner of a dressed fieldstone house foundation, as well as a kaolin pipe, redware, and creamware sherds (Mueller 1977).

Site BOU.2, the Chamber Rock Site, is large, flat-topped boulder located immediately west of the intersection of the AGT pipeline and Chamber Rock Road (Figure 4). The cultural use of this rock dates back to the European Contact period, if not earlier, and both European and Native oral tradition gives significance to the site (Keen 1937; Torrey 1953; Ramona Peters, personal communication, 2016). One account of Chamber Rock has a very Christian, European bent. In the *History of Bourne*, Betsey Keene (1937) indicates that the site was originally known as “Sacrifice Rock” due to sacrifices that Native Americans carried out there. Supposedly, when Richard Bourne attempted to put a stop to the practice, lightning struck and broke the rock, killing some Indians. Another version of the events surrounding Chamber Rock was recorded by Howard Torrey in 1953. In this account, the Wampanoag villagers from Comassakumkanet were suffering from a poor, dry growing season and their crops lay wilted on the ground. Allegedly, the sachem and his sagamores decided that a great sacrifice to the Thunder people was required to end the drought. They took a captive and brought him to rock to be sacrificed. As they prepared to burn the captive on the rock, the sky darkened and lightening flashed. Suddenly the storm broke and a huge bolt of lightning struck the rock, rendering it into pieces. The strike killed all of the Native leaders involved in preparing the sacrifice and left the intended victim unharmed. The Wampanoag took this as an indication that the Thunder people did not approve of human sacrifice, and the practice was ended. It is important to note that this version of the story was related to Torrey by Nathan Bourne Hartford, a Bourne descendent. To date, no archaeological testing has been carried in the immediate vicinity of the rock, so there are no recorded archeological materials associated with the site. Given its size and shape, it is possible that Chamber Rock may have served as rockshelter in the past.

Site BOU.3, Wishing Rock, is another large boulder located a short distance from Chamber Rock (Figure 4). The significance of this site is also related to oral tradition and dates at least as far back as the Contact period. Keene (1937) stated that a worn Native path ran past Wishing Rock. As local Native Americans passed the site, they would toss a stone upon the rock and

make a wish. Given this account, it seems likely that the site served as a memory pile. Information provided by the Tribal Historic Preservation Office of the Mashpee Wampanoag indicates that both Chamber Rock and Wishing Rock are important cultural sites in the present day (Ramona Peters, personal communication, September 2016).

The Bog Site, BOU.4, is located between Head of the Bay Road and Route 25 (Figure 4). The site consists of the remnants of an abandoned, undated cranberry bog and includes sand quarries, two sub-rectangular pits for pumping and holding excess water, the bog enclosure, and an irrigation ditch. BOU.4 was documented in 1977 (Mueller 1977).

The three remaining sites are located in the vicinity of the Aptucxet Trading Post Museum. These sites were all identified by Professor Barbara Luedtke in 1995, when she carried out an archaeological survey of the trading post area with field school students (Luedtke 1997). The Aptucxet Trading Post Museum Site (BOU.5) is located off Aptucxet Road along the Cape Cod Canal (Figure 4). The site is the purported location of an early ($17^{th}$-$18^{th}$ century) English trading post. Archaeological testing at the site resulted in the recovery of a variety of archaeological materials believed to related to the trading post: whetstones, a button mold, fire-cracked rock, architectural stone, gun flints, strike-a-lights, lithic debris, and nails (Luedtke 1997). Site BOU.6, known in the MHC files as Site #4, is located east of the Aptucxet Trading Post Museum on Aptucxet Road. Recovered cultural material include domestic materials, charcoal, and shell. The associated features included a cellar hole, stone-lined well, trash dump areas, ornamental plantings, and part of a stone wall. Finally, BOU.7 or Site #5 is a $19^{th}$-$20^{th}$-century cellar hole located west of the museum access road on Aptucxet Road. Associated features and materials included dump areas, abandoned farm equipment, glass, ceramics, brick, coal, and shell.

The 1825 Canal Survey map (Perrault, et al. 1825; Figures 3a and 3b) shows the "Old Indian Burial Ground," within the Project Focus Area at the southern end of Herring Pond along the Megansett Trail. This location is an historic-period cemetery associated with the Herring Pond Wampanoag tribe. Ground penetrating radar, conducted around the periphery of the cemetery in 2015, identified likely burials outside the accepted boundaries of the cemetery (Gately 2015).

### 6.2.2 Historic-Period Archaeological Sensitivity

Contact between Native American and Europeans occurred early on Cape Cod. It is likely that European fishermen fished the Cape waters in the early $16^{th}$ century and by the second quarter of the century several European explorers had visited the coast of New England. The early $17^{th}$ century brought English, French, and Dutch traders to the area and the start of hostilities between the Europeans and the local Native people (MHC 1986:56). The Monument and Scusset Rivers, now the Cape Cod Canal, were important local transportation routes and numerous Native American sites, including habitation areas and cemeteries, were located along their banks. The Native population on the Cape is believed to have been quite large in the early Contact Period, although the epidemics of 1617-1619 likely resulted in a rapid and dramatic population decline.

Following Contact, the Native residents of Cape Cod quickly became commercially and politically entangled with their new European neighbors. By 1627 the Aptucxet trading post (BOU.5) was established in the Project Focus Area and the first permanent European settlement was organized at Sandwich in 1637. New settlements at Barnstable, Yarmouth, and Nauset soon

followed. As the European population increased, Native groups were displaced and encouraged to settle on reservations and in praying towns (Christianized Indian settlement). The three major reservations on the Cape in this period were established around 1660 and included Mashpee, another reservation at the outlet of Herring Pond, straddling what are now the towns of Bourne and Plymouth, and the Potanunquut reservation in the Nauset area. By 1674, Richard Bourne reported seven congregations of "Praying Indians" (MHC 1986:72-73), although many of these were short-lived.

The 1825 Canal Survey map (Perrault, et al. 1825; Figures 3a and 3b) shows several Native sites at the southern end of Herring Pond and along Herring Pond Road, including two farmsteads and "Indian Hill." The "Old Indian Burial Ground," an historic-period cemetery associated with the Herring Pond Wampanoag tribe, is also located within the Project Focus Area at the southern end of Herring Pond along the Megansett Trail. Ground penetrating radar, conducted around the periphery of the cemetery in 2015, identified likely burials outside the accepted boundaries of the cemetery (Gately 2015). The documented presence of these sites, as well as the long-established history of the Wampanoag people in the Project Focus Area, suggests that the potential for contact and historic-period Native American sites is high throughout much of the study area. The 1825 map also depicts the locations of numerous Euro-American homes and farmsteads, most of which were located along the route of the proposed canal (Figures 3a and 3b). The presence of identified 17th-19th century house remains such as sites BOU.1, BOU.6, and BOU.7, suggest that more such sites likely exist in portions of the focus area that have not been greatly disturbed by modern development. Therefore, undisturbed and minimally-disturbed portions of the focus area are considered sensitive for historic-period archaeological resources.

An 1880 map of the Project Focus Area (Figure 6, Appendix A; Walker 1880) shows the most intensive settlement along existing roads, rather than along the rivers, as was the case in 1825. The most heavily settled areas in the focus area at this time appear to have been along the Herring Pond Road and present-day Head of the Bay Road. A "Herring House" is depicted in the location of the present-day Herring Run, near Foundry Pond between Bournedale Road and Route 6. The Old Colony Rail Road is shown on the map, running alongside much of the proposed canal route. Based on the 1880 map, it is likely that archaeological materials related to 19th-century farmsteads and railroad-related sites exist in minimally-disturbed portions of the focus area.

## 6.3 NATIVE AMERICAN CULTURAL SENSITIVITY

Archaeological sensitivity is largely based on environmental factors, the presence of documented archaeological resources and ethnographic and historic information. However, several portions of the Project Focus Area are also considered to have high levels of cultural and archaeological sensitivity by local Native American groups. These determinations are made on the basis of oral tradition, known archaeological sites, known burial sites, and other cultural knowledge. Coordination with federally-recognized Native American tribes on the Cape (the Mashpee and Gay Head [Aquinnah] Wampanoag) resulted in the identification of several areas of cultural sensitivity (Figure 5). These include most of the northern and eastern portions of the military base at Camp Edwards, and a linear area that runs south from Herring Pond, along Herring Pond Road, crosses the canal and extends into the northern portion of the base, and the locations of Chamber Rock (BOU.2) and Wishing Rock (BOU.3). The Wampanoag Tribe of Gay Head (Aquinnah) also indicated that any undeveloped areas along the north and south banks of the canal should be considered culturally sensitive (Elizabeth Perry, personal communication,

2016). These areas overlap with areas identified as archaeologically sensitive, indicating that their importance to Native people extends into the deep past. The Herring Pond Wampanoag Tribe, whose traditional lands are in the northern portion of the focus area in the vicinity of Herring Pond, consider the area surrounding Herring Pond to have a high level of cultural sensitivity (Melissa Ferretti, personal communication, September 2016) (Figure 5, Appendix A).

# 7.0 EVALUATION OF POTENTIAL EFFECTS ON HISTORIC RESOURCES

The new bridges and road improvement options in the Cape Cod Canal Transportation Study can be expected to affect historic properties in the Project Focus Area that are listed in the National Register of Historic Places (or are potentially eligible for listing in the NRHP), the State Register of Historic Places, and the Inventory of Historic and Archaeological Assets of the Commonwealth.

Below is a preliminary review of the anticipated effects of the options as depicted on the MESA Information Request Canal Crossing and Approach Options, Cape Cod Canal Transportation Study Overview (received by AHS on September 9, 2016).

## 7.1 MIDDLE BRIDGE 1

Middle Bridge 1 involves a new highway bridge roughly halfway between the Bourne and Sagamore Bridges that would be accessible on the north side from Route 25 via a traffic circle, and from Route 6 (Scenic Highway) via a partial cloverleaf interchange (Figure 2, Appendix A).

Middle Bridge 1 could have a direct and indirect adverse effect on the Cape Cod Canal itself (BOU.AF), which is potentially NRHP eligible (Photographs 1-3, Appendix D). Middle Bridge 1 is very close to the Herring Run Recreation Area Fish Ladder (BOU.938), a contributing resource to the potential Cape Cod Canal NRHP district. It could have a potential direct or indirect adverse effect on the Herring Run Fish Ladder (Photograph 23, Appendix D).

This option could have a potential indirect adverse effect on integrity of setting for the southwest part of Bournedale (BOU.I). The Nathan Bourne Ellis House/Bournedale Lodge (BOU.211, 212, 213) at 854 Route 6/Scenic Highway in this area of Bournedale are potentially individually eligible for the NRHP (Photograph 27, Appendix D).

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 2.

## 7.2 MIDDLE BRIDGE 2

Middle Bridge 2 involves a new highway bridge roughly halfway between the Bourne and Sagamore Bridges that would be accessible on the south side from Route 6 via a new road (Figure 2, Appendix A).

Middle Bridge 2 could have direct and indirect adverse effects on the Cape Cod Canal itself (BOU.AF), which is potentially NRHP-eligible.

It could also have a potential direct adverse effect on the Cape Cod Air Station – Otis Air Force Base (BOU.B) if that entire area is NRHP-eligible, which has not been determined (see section 5.4.5).

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 3.

## 7.3 SANDWICH ROAD

Sandwich Road work involves improvements to the existing roadway and its interchange with Route 6, and a new connection to the Bourne Rotary (Figure 2, Appendix A).

Potential Sandwich Road improvements not appear to have direct or indirect effects on any inventoried areas (such as BOU.A Keene Street-Sandwich Road Area), or other identified standing historic resources.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 4.

## 7.4 RELOCATED EXIT 1C 4 LEG ROUNDABOUT EFFECTS

Relocated Exit 1C involves a new Route 6 exit and new road to Route 6A (Figure 7-9, Appendix A). The road would be constructed within an existing power transmission line corridor, terminating in a roundabout at the intersection with Route 6 and Main Street.

Relocated Exit 1 could have a possible indirect adverse effect on west end of the Route 6A West Area (SDW.G), which is listed in the State Register and is located within the Old King's Highway Regional Historic District (SDW.R). Inventoried resources that appear to be in close proximity to the proposed Relocated Exit 1C include the Saddle and Pillion Burial Ground (SDW.802) and a collection of 20th-century buildings including motor courts and houses (SDW.489, SDW.490, SDW.491, SDW.492, SDW.493, SDW.494, SDW.495, SDW.496, SDW.497, and others.) See Photographs 72 to 74, Appendix D. The Watson Freeman House (SDW.100) has been demolished.

It could also have an indirect adverse effect on the west end of the Main Street – Route 130 Area (SDW.I), which is listed in the State Register and is located within the Old King's Highway Regional Historic District (SDW.R). Inventoried resources that appear to be in close proximity to the proposed Relocated Exit 1C include houses at 8, 12, and 14 Main Street (SDW.504, 505, and 506). The road alignment appears to encroach on the front yards of these three properties.

The proposed Relocated Exit 1C could have a direct or indirect adverse effect on the east end of South Sagamore (SDW.V), which is potentially NRHP eligible as a district. Inventoried resources that appear to be in close proximity to the proposed Relocated Exit 1 include the early 20th-century Sagamore Inn (BOU.346), stone markers BOU.925 and BOU.927, the early 18th-century Freeman House and Barn (BOU.194 and 195), and the early 20th-century Rogers House (BOU.345).

The road alignment appears to have a direct adverse effect on Bourne Highway Marker BOU.927, located in front of the Sagamore Inn at 131 Sandwich Road (BOU.346), and also Town Line Marker BOU.927, located across the street from the Sagamore Inn. These markers are not individually eligible for the NRHP.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 5.

## 7.5 ROUTE 3 TO ROUTE 25

Route 3 to Route 25 would construct a new road connecting Route 3 and the Sagamore Bridge with Route 25 (Figure 2, Appendix A). The new road would connect to Route 25 via a rotary, and to Route 3 and the Sagamore via ramp interchanges.

A potential new connector from Route 3 to Route 25 does not appear to have direct or indirect effects on inventoried areas (such as Head of the Bay BOU.C, Bournedale BOU.I, North Sagamore BOU.O, Savery Ave BOU.P or the Cape Cod Canal BOU.AF), or on other identified standing historic resources.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 6.

## 7.6 SCENIC HIGHWAY

Scenic Highway work would involve improvements to the existing highway (Figure 2, Appendix A).

Improvements to the Scenic Highway (Route 6) between the Bourne and Sagamore bridges could have an overall indirect adverse effect (integrity of setting) on the Cape Cod Canal (BOU.AF), a potential NRHP-eligible district. The Scenic Highway is very close to the Herring Run Recreation Area Fish Ladder (BOU.938), a contributing resource in the potential canal historic district. Improvements to the highway could have a potential direct or indirect adverse effect on the fish ladder (Photograph 23, Appendix D).

In Bournedale, historic resources close to the Scenic Highway that are potentially individually eligible for the NRHP include the Nathan Bourne Ellis House/Bournedale Lodge (BOU.211, 212, 213) at 854 Route 6/Scenic Highway (Photograph 27, Appendix D). Improvements to the highway could have a potential direct or indirect adverse effect on this property.

Other inventoried resources that are close to the Scenic Highway include several mid 19th-century houses and commercial properties (BOU.204, BOU.205, BOU.206, BOU.207). The eligibility of Bournedale as a NRHP-eligible district has not been fully assessed. Improvements to the highway could have a potential direct on BOU.204 or BOU.205, or an indirect adverse effect (integrity of setting) on all of these properties.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 7.

## 7.7 SAGAMORE TWIN

Sagamore Twin would construct a new bridge immediately west of the existing Sagamore Bridge (Figure 2, Appendix A). New ramps would connect the existing and new bridges with Route 3 and Route 6/Scenic Highway north of the canal, and to Route 6 south of the canal.

The new twin bridge would have a potential adverse and definitely indirect adverse effect on the Sagamore Bridge, which MHC has classified as individually NRHP-eligible (Photograph 7, Appendix D).

The new twin bridge and its approaches would have a potential direct or indirect adverse effect on the Cape Cod Canal, a potential NRHP-eligible district.

The new twin bridge approaches could have a potential indirect adverse effect on North Sagamore and Savery Avenue, possibly affecting their integrity of setting if they are determined to be NRHP-eligible districts.

The new twin bridge approaches could have a potential indirect adverse effect on South Sagamore, especially the Adams Street area, which could be included in a South Sagamore NRHP district (see Figure 2, Appendix A).

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 8.

## 7.8 NEW ROUTE 6 EB TRAVEL LANE

New Route 6 EB Travel Lane would extend from the Sagamore bridge to the Route 130 interchange. The new lane would be located on land currently owned by MassDOT, within the wide ROW (Figures 10-11, Appendix A).

SDW.906 and 907 are two Route 6 bridges over Route 130. They are within the Old King's Highway Regional Historic District (SDW.R) and they are SR-listed (Photograph 71, Appendix D). The new Route 6 EB travel lane would have a direct adverse effect on bridge SDW.907 (eastbound), and an indirect adverse effect on bridge SDW.906. (westbound) (Figure 11, Appendix A).

The new Route 6 EB travel lane could have a potential indirect adverse effect (integrity of setting) on the Cape Cod Air Station – Otis Air Force Base (BOU.B) if that entire area is NRHP eligible, which has not been determined. Such a potential indirect adverse effect would result only if work extends beyond the existing ROW.

In Sandwich, the area north of Route 6 is included in the Old King's Highway Regional Historic District (SDW.R) & SR listed. The new Route 6 EB travel lane could have a potential indirect adverse effect (integrity of setting) for the overall area, only if work extends beyond the existing ROW.

Shawme Road (SDW.F) in Sandwich is a potentially NR-eligible area. It is also included in the Old King's Highway Regional Historic District (SDW.R) & is SR-listed. The new Route 6 EB travel lane could have potential indirect adverse effect on integrity of setting, only if work extends beyond the existing ROW.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 9.

## 7.9 BOURNE BRIDGE REPLACEMENT & IMMEDIATE APPROACHES

Bourne Bridge involves the replacement of the Bourne Bridge and improved ramps and roadways to access the bridge (Figure 2, Appendix A).

This option would have a direct adverse effect on the Bourne Bridge, which MHC has classified as individually NRHP-eligible (Photograph 5, Appendix D). It would have a potential direct or indirect adverse effect on the Cape Cod Canal, a potential NRHP-eligible district.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 10.

## 7.10 BELMONT CIRCLE AND SCENIC HIGHWAY TO ROUTE 25 RAMP

Belmont Circle involves a new rotary and road alignments to replace the Belmont Circle in Buzzard's Bay north of the Bourne Bridge (Figure 12, Appendix A)

Improvements to Belmont Circle and its connections in Buzzard's Bay do not appear to have direct or indirect effects on inventoried areas or other identified standing historic resources.

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 11.

## 7.11 BOURNE ROTARY ALTERNATIVE 2

Bourne Rotary Alternative 2 involves new intersections to replace the Bourne Rotary south of the Bourne Bridge (Figure 13, Appendix A). It also includes improved ramps and roadways to access the bridge.

The Bourne Rotary Alternative 2 and its connections east of Bourne Village could have indirect adverse effects on inventoried areas and National Register-listed properties in Bourne Village to the west. The proposed realignment of Sandwich Road could have a direct or indirect adverse effect on the Arabella Parker-George Ellis House (BOU.49) at 66 Sandwich Road, which is potentially NRHP-eligible as an individual property (Photograph 42, Appendix D).

To the east on Sandwich Road, these improvements might have had a potential direct or indirect adverse effect on the Gershom Ellis/Henry S. Blackwell House at 201 Sandwich Road (BOU.50). This property was formerly identified as a potential individually-eligible NRHP resource, but has since been modified and is no longer eligible (Photograph 48, Appendix D).

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 12.

## 7.12 BOURNE ROTARY ALTERNATIVE 3A

Bourne Rotary Alternative 3A involves new intersections to replace the Bourne Rotary south of the Bourne Bridge (Figure 14, Appendix A). It also includes improved ramps and roadways to access the bridge.

The Bourne Rotary Alternative 3A and its connections east of Bourne Village could have indirect adverse effects on inventoried areas and National Register-listed properties in Bourne Village to the west. The proposed realignment of Sandwich Road could have a direct or indirect adverse effect on the Arabella Parker-George Ellis House (BOU.49) at 66 Sandwich Road, which is potentially NRHP-eligible as an individual property (Photograph 42, Appendix D).

To the east on Sandwich Road, these improvements might have had a potential direct or indirect adverse effect on the Gershom Ellis/Henry S. Blackwell House at 201 Sandwich Road (BOU.50). This property was formerly identified as a potential individually-eligible NRHP resource, but has since been modified and is no longer eligible (Photograph 48, Appendix D).

The type of proposed construction will affect the total number of resources that would be adversely affected, either directly or indirectly.

Refer to Appendix E, Table 13.

# 8.0 EVALUATION OF POTENTIAL EFFECTS ON ARCHAEOLOGICAL AND CULTURAL/ETHNOGRAPHIC RESOURCES

AHS conducted an archaeological sensitivity assessment of the Cape Cod Canal Transportation Improvement Project Focus Area and potential new roadway alignments (Figure 1). The Project Focus Area includes the land that begins one mile west of the Bourne Bridge and extends to a point one mile east of the Sagamore Bridge. It is located almost entirely within the town of Bourne, with a small section in Plymouth. Two of the proposed alternatives (the Sagamore Twin and Relocated Exit 1 options) also extend a short distance into the town of Sandwich. Archaeological sensitivity was assessed based on a review of previously identified archaeological sites, historical maps and documentary sources, environmental characteristics, and consultation with local Native American groups regarding areas of cultural sensitivity.

Based on a review of the environment, archaeology, history, and areas of contemporary Native American cultural sensitivity, AHS assessed the sensitivity of the Project Focus Area for pre-colonial Native American and historic-period archaeological resources. In general, the proximity of the focus area to the Cape Cod Canal, which widened and joined the previously disconnected Manomet (or Monumet) and Scusset rivers, indicates that, in general terms, most of the Project Focus Area has very high archaeological potential. The Manomet River originally ran from the extant Great Herring Pond to Buzzards Bay, while the Scusset was a tidal river surrounded by a saltwater marsh system. These waterways were once a locus of extensive and intensive Native American settlement and subsistence activities and large-scale villages, as well as smaller settlements traditional burial grounds are documented along the former river channels. In the historic period, following the arrival and establishment of European communities on the Cape, these areas continued to be an important locus of settlement. As noted above, the 1825 map of the proposed canal area shows a series of farmsteads along the banks of the two rivers (Figures 3a and 3b).

Areas of cultural sensitivity were identified by the Mashpee and Gay Head (Aquinnah) Wampanoag Tribes, and by the Herring Pond Wampanoag tribe. Some of these areas overlap /coincide with recorded archaeological sites, but some do not. All of the Wampanoag tribes concur that the entire Project Focus Area is highly sensitive for buried archaeological resources related to Native American occupation of the Cape for thousands of years.

A more-detailed sensitivity assessment of the individual potential alternatives is provided below, along with a discussion of AHS's recommendations for archaeological testing and/or monitoring in sensitive areas and the areas considered to have archaeological sensitivity. Table 14 (Appendix E) presents a summary of the archaeological sensitivity and recommendations for each potential construction alternative based on proximity to documented archaeological sites and areas of identified Native American cultural sensitivity.

## 8.1 MIDDLE BRIDGE 1

The Middle Bridge 1 option runs from just north of the Plymouth/Bourne town line to the canal along the path of an existing utility corridor and extends to Route 6 on the north side of the canal. The northern portion of this option traverses an area containing two known archaeological sites, 19-PL-345 and 19-BN-821 (Table 14, Appendix E; Figure 4, Appendix A). While neither site contained diagnostic artifacts, the presence of these sites indicates that this area was used by past Native people. The Middle Bridge 1 option also includes two proposed ramps, located at the juncture of the alignment with Route 6 (Scenic Highway). The proposed west ramp overlies an obviously disturbed gravel pit area, but undeveloped areas exist around the periphery of the pit, and site 19-BN-937 is located immediately to the west. The proposed east ramp lies directly adjacent to Foundry Pond, which is part of Great Herring Pond and Herring River drainage. Documented sites in the vicinity of the ramps include 19-BN-690, 19-BN-224, and 19-BN-685. This entire area may have once been part of a Late Woodland/Contact village site and is considered to have a high level of archaeological sensitivity.

Refer to Appendix E, Table 14.

## 8.2 MIDDLE BRIDGE 2

The Middle Bridge 2 option, which extends across the canal from the north bank to join Route 6, also follows a portion of the existing utility corridor. Documented archaeological sites in this area include 19-BN-654, which falls within the path of the proposed option, as well as sites 19-BN-656 and 19-BN-653, which are adjacent to the alignment (Table 14, Appendix E; Figure 4, Appendix A). All three sites are low density lithic findspots, but the presence of these materials indicates Native American activity in this area and suggests that there is strong potential for additional archaeological resources nearby.

Refer to Appendix E, Table 14.

## 8.3 SANDWICH ROAD

The Sandwich Road option runs along existing Sandwich Road, from the Bourne Rotary, along the south side of the canal. While this option only intersects with one identified site (19-BN-654) (Table 14, Appendix E; Figure 4, Appendix A) its proximity to the canal, which was built roughly along the course of the Cape's major rivers, indicates that undeveloped portions of this option should be considered highly sensitive for archaeological resources. Unlike much of the Project Focus Area, the course of the Sandwich Road has not been subjected to extensive archaeological survey, increasing the potential for as yet undiscovered archaeological resources.

Refer to Appendix E, Table 14.

## 8.4 RELOCATED EXIT 1C 4 LEG ROUNDABOUT EFFECTS

The Relocated Exit 1C involves a new Route 6 exit and new road to Route 6A (Figure 7-9, Appendix A). The road would be constructed within an existing power transmission line corridor, terminating in a roundabout at the intersection with Route 6 and Main Street.

Most of this route does not directly impact any known archaeological sites, but the proposed rotary and road realignments at the junction of Route 6A, Main Street, and Tupper Road, at the eastern end of the alternative is situated in close proximity to the artifact-dense pre-contact Town Line Site and Town Line Findspots (19-BN-943, 19-BN-908, 19-BN-913, 19-BN-914, 19-BN-915) identified along the town line during a gas pipeline project (Table 14, Appendix E; Figures 4 and 7, Appendix A). The presence of these sites suggests that undeveloped portions of the eastern end of Exit 1C option have high archaeological sensitivity. Refer to Appendix E, Table 14.

## 8.5 ROUTE 3 TO 25

The proposed Route 3 to Route 25 option, which follows a powerline for most of its path, will require careful assessment due to the proximity of Great Herring Pond and Herring River. The roundabout located on the western end of this route is not far from Goat Pasture Pond, as well as documented pre-colonial site 19-BN-345. The proposed alignment crosses pre-colonial site 19-BN-821 and historic archaeological site BOU.2. Additionally, site historic site BOU.3 is located a short distance south of the roadway (Table 14, Appendix E; Figure 4, Appendix A). These historic sites represent Sacrifice Rock and Wishing Rock, two places on the landscape that are identified as having cultural significance to contemporary Native groups, as well as historical and archaeological significance.

Refer to Appendix E, Table 14.

## 8.6 SAGAMORE TWIN

The alignment for the proposed Sagamore Twin option should be carefully assessed as it is likely highly sensitive for archaeological resources in the areas immediately to the north and south of the canal, as well as along Route 6 as it extends to the southeast into Sandwich. Undeveloped areas near the canal may contain remnants of past Native American settlements or cemeteries and numerous archaeological sites are identified along Route 6 where it skirts the edge of the military base (Table 14, Appendix E; Figure 4, Appendix A).

Refer to Appendix E, Table 14.

## 8.7 SCENIC HIGHWAY

The Scenic Highway option, which follows the path of existing Route 6 along the north bank of the canal, crosses several documented sites (19-BN-224, 19-BN-690, and 19-BN-937), as well as long stretches of undeveloped land adjacent to the canal (Figure 4, Appendix A). The proximity of this route to the canal suggests that much of the area is highly sensitive for buried cultural resources. Any alterations to or widening of the road in the area have the potential to impact as yet undiscovered archaeological sites.

Refer to Appendix E, Table 14.

## 8.8 NEW ROUTE 6 EB TRAVEL LANE

The New Route 6 EB Travel Lane would extend from the Sagamore bridge to the Route 130 interchange. The new lane would be located on land currently owned by MassDOT, within the

existing ROW (Figures 4, 10, and 11, Appendix A). Numerous archaeological sites have been identified along this stretch of Route 6 (19-BN-631, 19-BN-632, 19-BN-633, 19-BN-634, 19-BN-635, 19-BN-901, 19-BN-902, 19-BN-903, 19-BN-907, 19-BN-910, 19-BN-911, 19-BN-912, 19-BN-914, and 19-BN-987; Figure 4, Appendix A) and the expansion of the road would likely result in direct effects to several of these sites (19-BN-634, 19-BN-687, 19-BN-902, 19-BN-910, 19-BN-911, 19-BN-912, and 19-BN-987) and potential effect to sites 19-BN-631, 19-BN-632, 19-BN-633, 19-BN-901, and 19-BN-903. At the southern end of the Route 6 EB Travel Lane, near the Route 130 interchange, one additional archaeological site, 19-BN-909, is located adjacent to Route 6, and the expansion of Route 6 in this area would result in a direct effect to that site (Figures 4 and 11; Appendix A).

Refer to Appendix E, Table 14.

## 8.9 BOURNE BRIDGE REPLACEMENT AND IMMEDIATE APPROACHES

The Bourne Bridge portion of the project involves the replacement of the Bourne Bridge and improved ramps and roadways to access the bridge (Figures 4, Appendix A). The Bourne Bridge Replacement and Immediate Approaches option may encounter components related to historic sites BOU.1 and BOU.4 and pre-colonial site 19-BN-244 (Table 14, Appendix E; Figure 4, Appendix A). Numerous archaeological sites have been identified in the area west of this alignment. Undeveloped areas along this route are likely sensitive for archaeological resources.

Refer to Appendix E, Table 14.

## 8.10 BELMONT CIRCLE AND SCENIC HIGHWAY TO ROUTE 25 RAMP

Belmont Circle involves a new rotary and road alignments to replace the existing Belmont Circle in Buzzard's Bay north of the Bourne Bridge (Figures 4 and 12, Appendix A). There are no documented archaeological sites within the proposed option footprint, however, there are two documented archaeological sites (19-BN-244 and BOU.1) adjacent to areas of proposed alteration (Table 14, Appendix E; Figure 12, Appendix A). Undeveloped portions of the overall area are highly sensitive for pre-colonial archaeological resources. Two Late Woodland/Contact periods Native American sites, the Grove Field ossuary site19-BR-612, and site 19-BR-689 were identified a short distance south of the Belmont rotary near Bourne Pond. The area around the pond is highly sensitive for archaeological resources. Two additional sites, 19-BN-986 and 19-BN-987 are identified on the west side of the pond (Figure 4, Appendix A; Table 14, Appendix E).

Refer to Appendix E, Table 14.

## 8.11 BOURNE ROTARY ALTERNATIVE 2

Bourne Rotary Alternative 2 involves new intersections to replace the Bourne Rotary south of the Bourne Bridge (Figures 4 and 13, Appendix A). It also includes improved ramps and roadways to access the bridge. No archaeological sites are documented within the planned road alignment areas, but undeveloped portions of the overall area are considered sensitive for archaeological resources. Numerous archaeological sites have been identified approximately one mile east of Route 28, south of the rotary within Camp Edwards. To the west of the Alternative 3A alignment, documented archaeological sites include 19-BN-218, the Aptuxet Petroglyph, and several sites associated with the Aptuxet Trading Post (BOU.5, BOU.6, BOU.7). Two pre-contact sites (19-BN-

786 and 19-BN-787) are also identified along the present-day canal, about one mile west of the alternative 3A alignment (Table 14, Appendix E; Figure 4, Appendix A).

Refer to Appendix E, Table 14.

## 8.12 BOURNE ROTARY ALTERNATIVE 3A

Bourne Rotary Alternative 3A involves new intersections to replace the Bourne Rotary south of the Bourne Bridge (Figures 4 and 14, Appendix A). It also includes improved ramps and roadways to access the bridge. No archaeological sites are documented within the planned road alignment areas, but undeveloped portions of the overall area are considered sensitive for archaeological resources. Numerous archaeological sites have been identified approximately one mile east of Route 28, south of the rotary within Camp Edwards. To the west of the Alternative 3A alignment, documented archaeological sites include 19-BN-218, the Aptuxet Petroglyph, and several sites associated with the Aptuxet Trading Post (BOU.5, BOU.6, BOU.7). Two pre-contact sites (19-BN-786 and 19-BN-787) are also identified along the present-day canal, about one mile west of the alternative 3A alignment (Table 14, Appendix E; Figure 4, Appendix A).

Refer to Appendix E, Table 14.

# 9.0 CONCLUSIONS AND RECOMMENDATIONS

The Project Focus Area contains a large number of historic resources, including bridges, buildings, districts and more, many of which are listed in or eligible for listing in the NRHP. Besides the Bourne and the Sagamore bridges (determined by MHC as individually eligible for the NRHP), and the Cape Cod Canal itself, relatively few resources would be directly affected by the project alternatives, with the caveat that design specifications for the alternatives have not been developed. Depending on the actual build specifications of the selected alternative, the assessment of the project effects may change.

The majority of the Project Focus Area, that is, all undeveloped or undisturbed land, including lawns, is considered to have high potential for archaeological resources. As an alternative is selected and project plans are refined, detailed walkover survey and close visual assessment of potential alignment routes by professional archaeologists would be necessary to refine the archaeological sensitivity of these areas. The archaeological potential of undisturbed ground surfaces would be assessed based on soil composition (i.e., are the soils well-drained, poorly-drained, glacial till, etc.) and the proximity of the alignment to natural resources such as fresh water. The walkover and visual inspection would also facilitate the identification of above-ground historic resources that may signal an area's archaeological potential for historic archaeological sites. In addition to the visual assessment, a series of hand-powered soil probe samples would be taken across the Project Focus Area to further assess the integrity of the soils.

Refined areas of archaeological sensitivity in the Project Focus Area should then undergo systematic subsurface testing in the form of an intensive (locational) archaeological survey. An intensive (locational) survey is defined as "a systematic and detailed archaeological field investigation for the purpose of locating and identifying the sites which exist in a given area" (950 CMR 70.04). The tasks of the intensive survey include preparation of a detailed research design and application for a permit from the Massachusetts State Archaeologist (as mandated by Massachusetts General Laws, Chapter 9, Sections 26-27c and its implementing regulations 950 CMR 70); manual subsurface testing, laboratory processing and curation of any recovered artifacts; and preparation of a technical report.

The conclusions and recommendations herein are the opinion of the historic preservation consultant. Actual determinations of National Register eligibility and further assessment of effects are properly part of the ongoing consultative process among MassDOT and MHC, and will be further developed as the project progresses.

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# APPENDIX A: FIGURES

Figure 1: Cape Cod Canal improvement alternatives and study focus area.

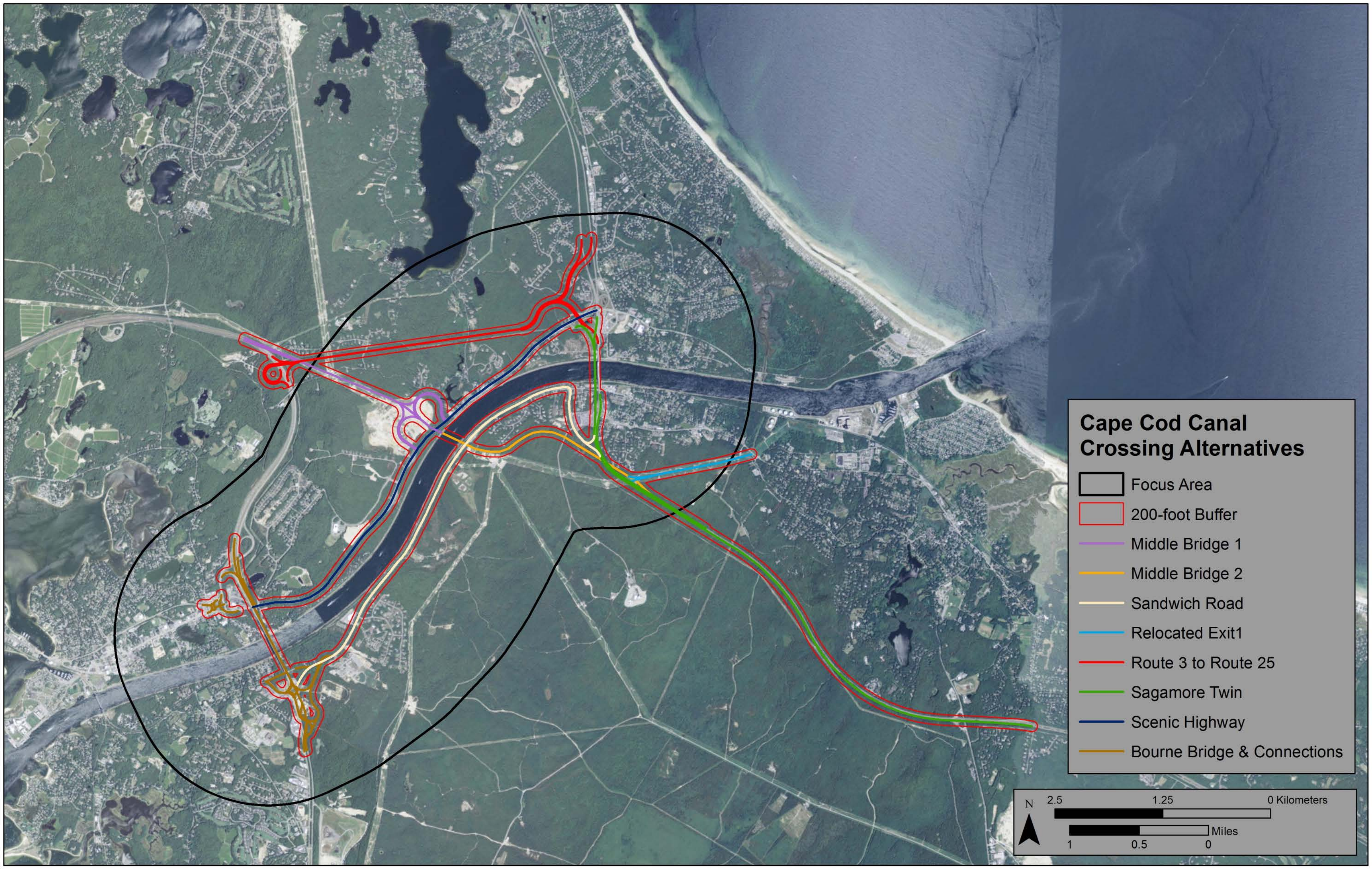


Figure 2. Historic resources in the project focus area and surrounding areas.

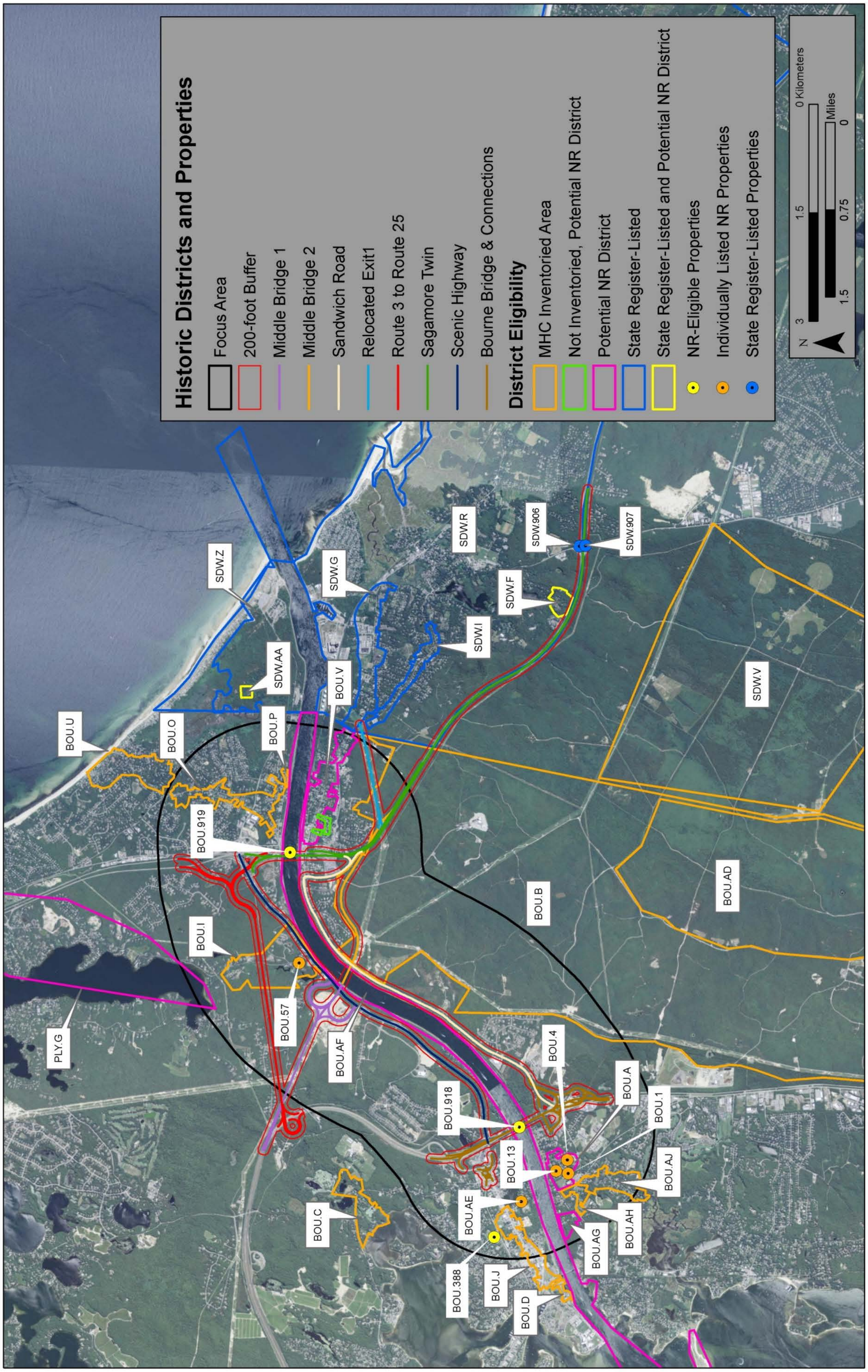


Figure 3a: West half of the 1825 Perrault map of the proposed Cape Cod Canal, showing the approximate locations of the Cape Cod Canal improvement alternatives.

Figure 3b: East half of the 1825 Perrault map of the proposed Cape Cod Canal, showing the approximate locations of the Cape Cod Canal improvement alternatives.

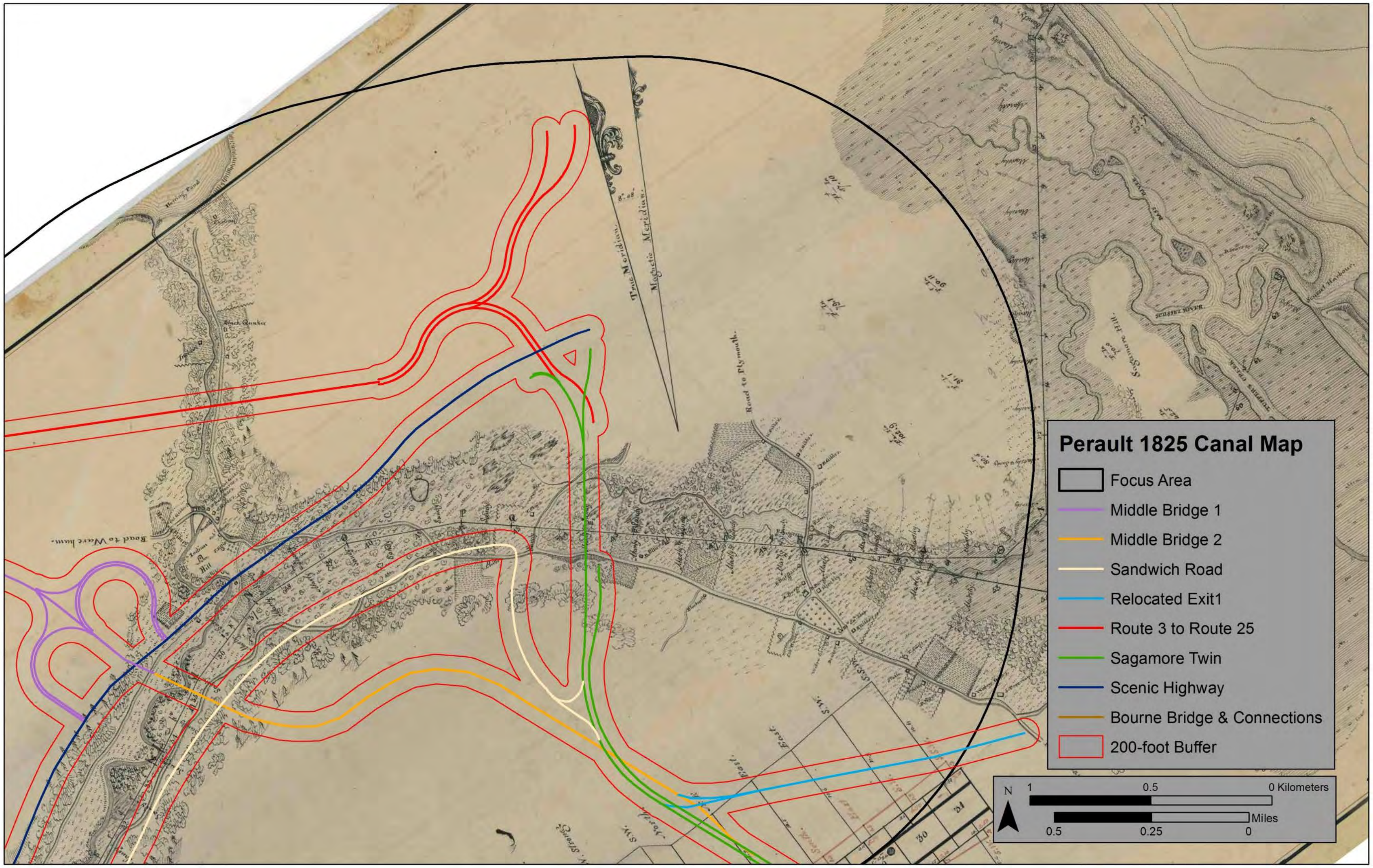


Figure 4: Aerial view of Cape Cod Canal showing focus area, Cape Cod Canal improvement alternatives, and documented archaeological sites.

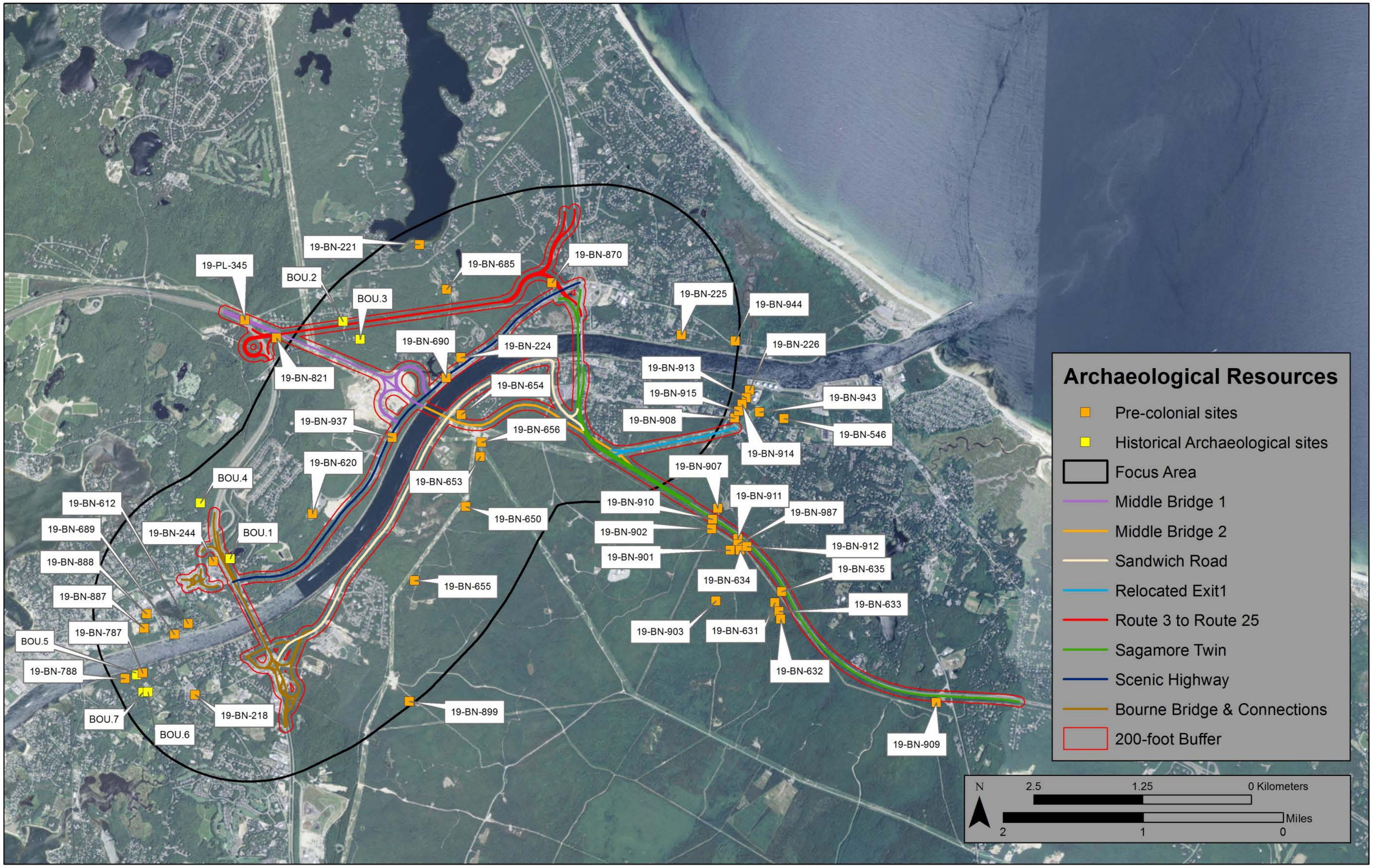


Figure 5: Aerial view of the Cape Cod Canal, showing focus area, improvement alternatives, and specific areas deemed culturally sensitive by the Mashpee Wampanoag ' all unbuilt land within project area is considered archaeologically and culturally sensitive by the Mashpee, Gay Head (Aquinnah), and Herring Pond Wampanoag.

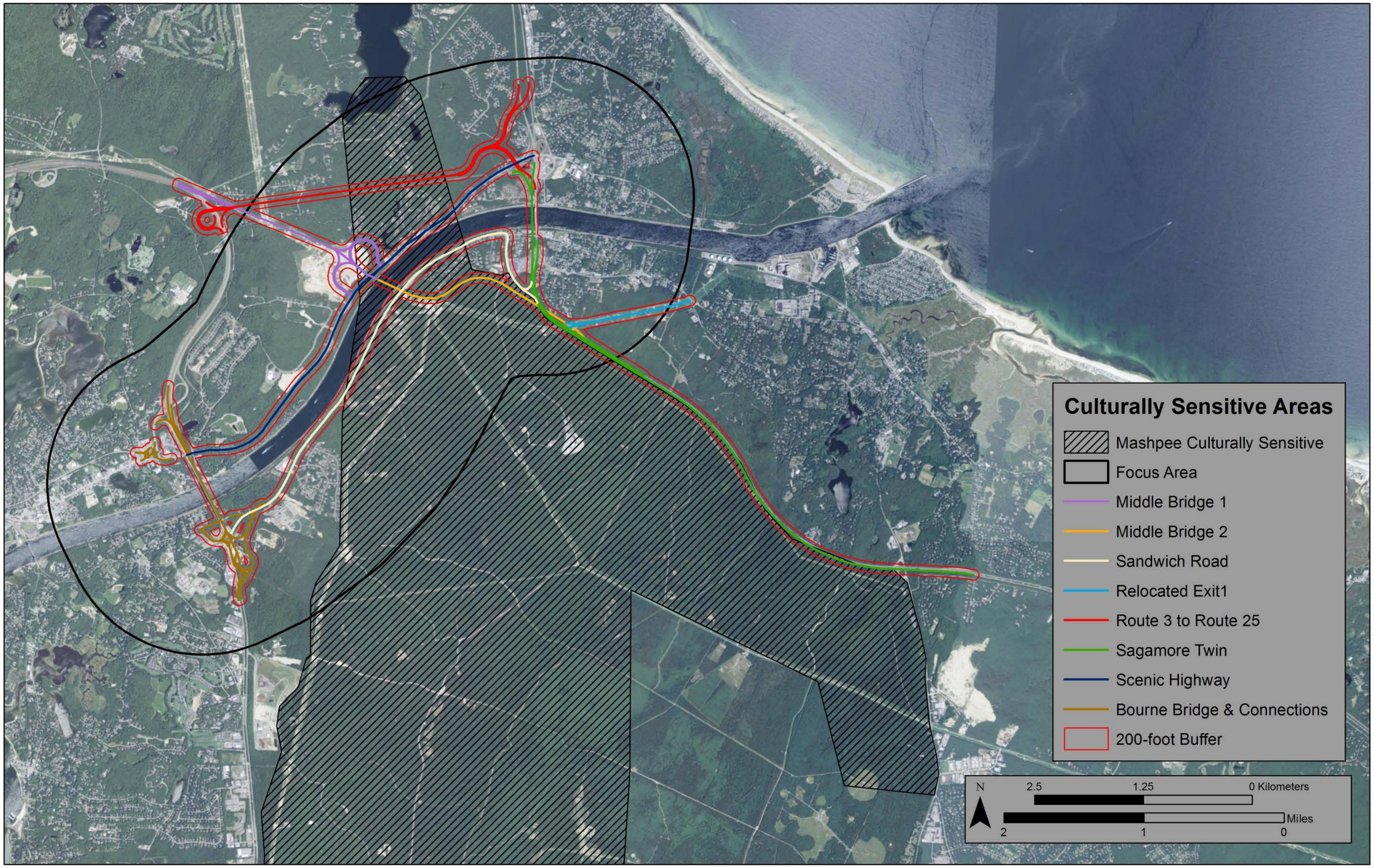


Figure 6: Detail of the 1880 map of Sandwich, showing the approximate locations of the focus area and improvement alternatives.

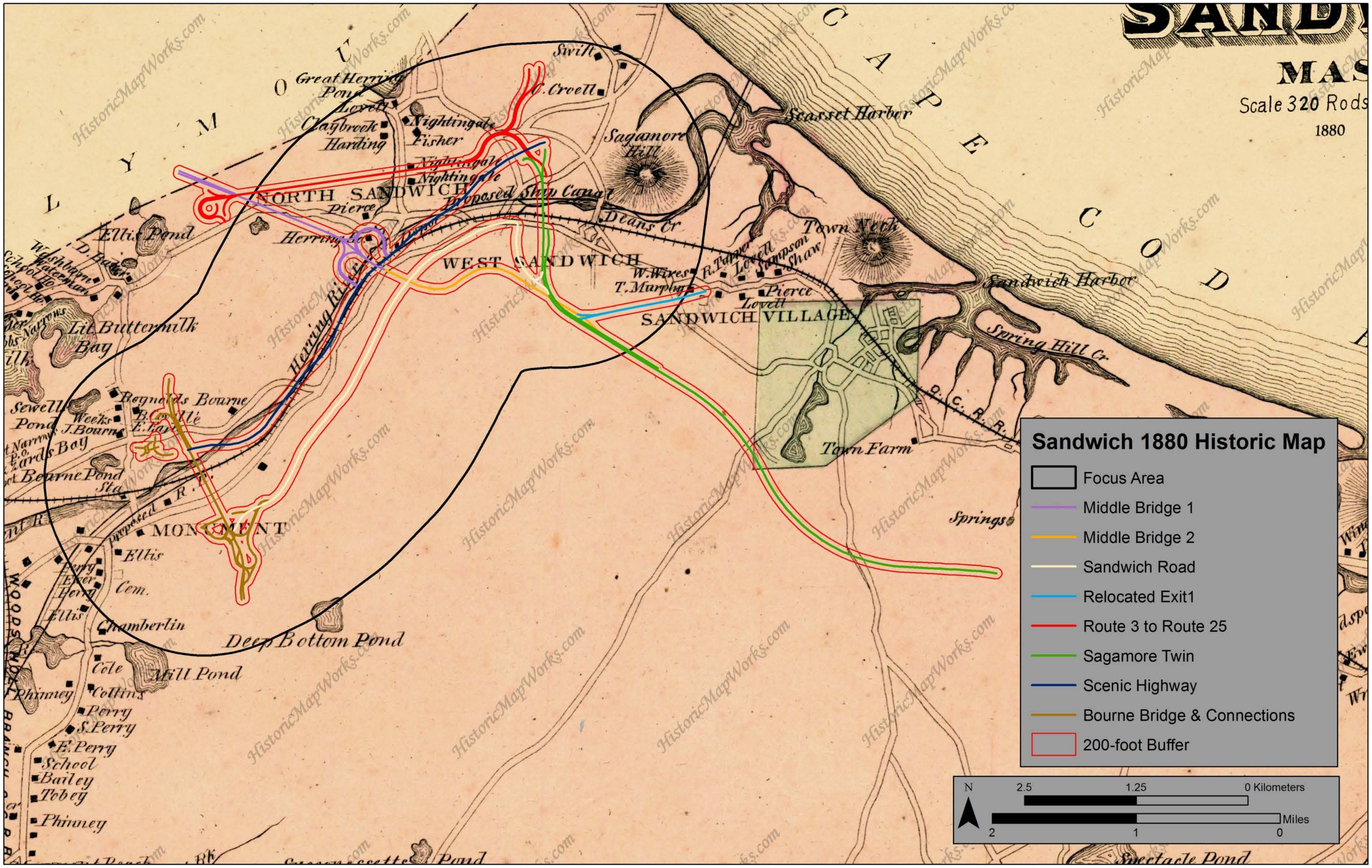


Figure 7: Relocated Exit 1C Design Concepts 4 Leg Roundabout Alternative.

Figure 8. Relocated Exit 1C Design Concept Route 6 EB On and Off Ramps.

Figure 9. Relocated Exit 1C Design Concept at Grade Ramp along Utility Corridor.

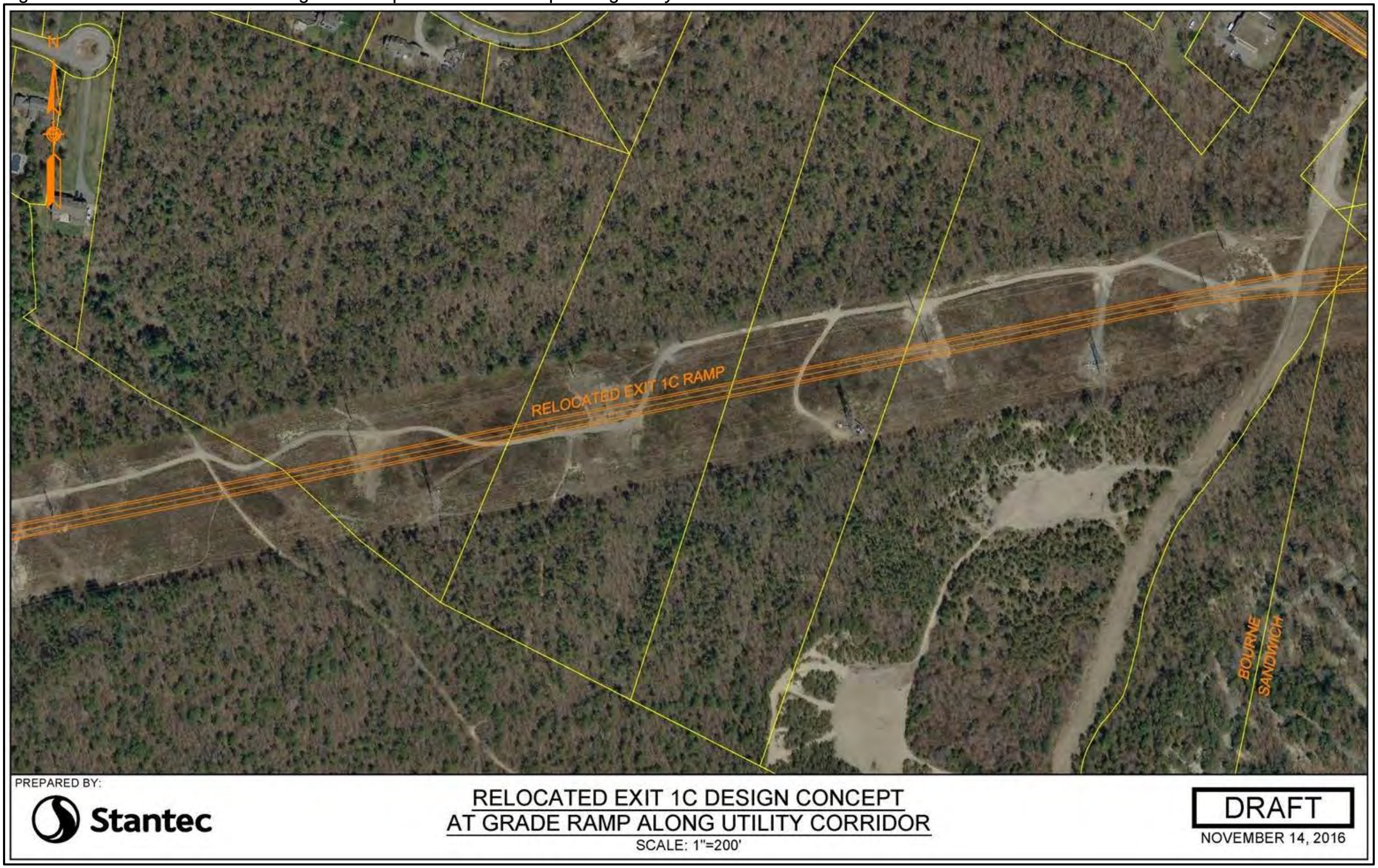


Figure 10. Route 6 Add-a-Lane Design Concepts, Northern End.

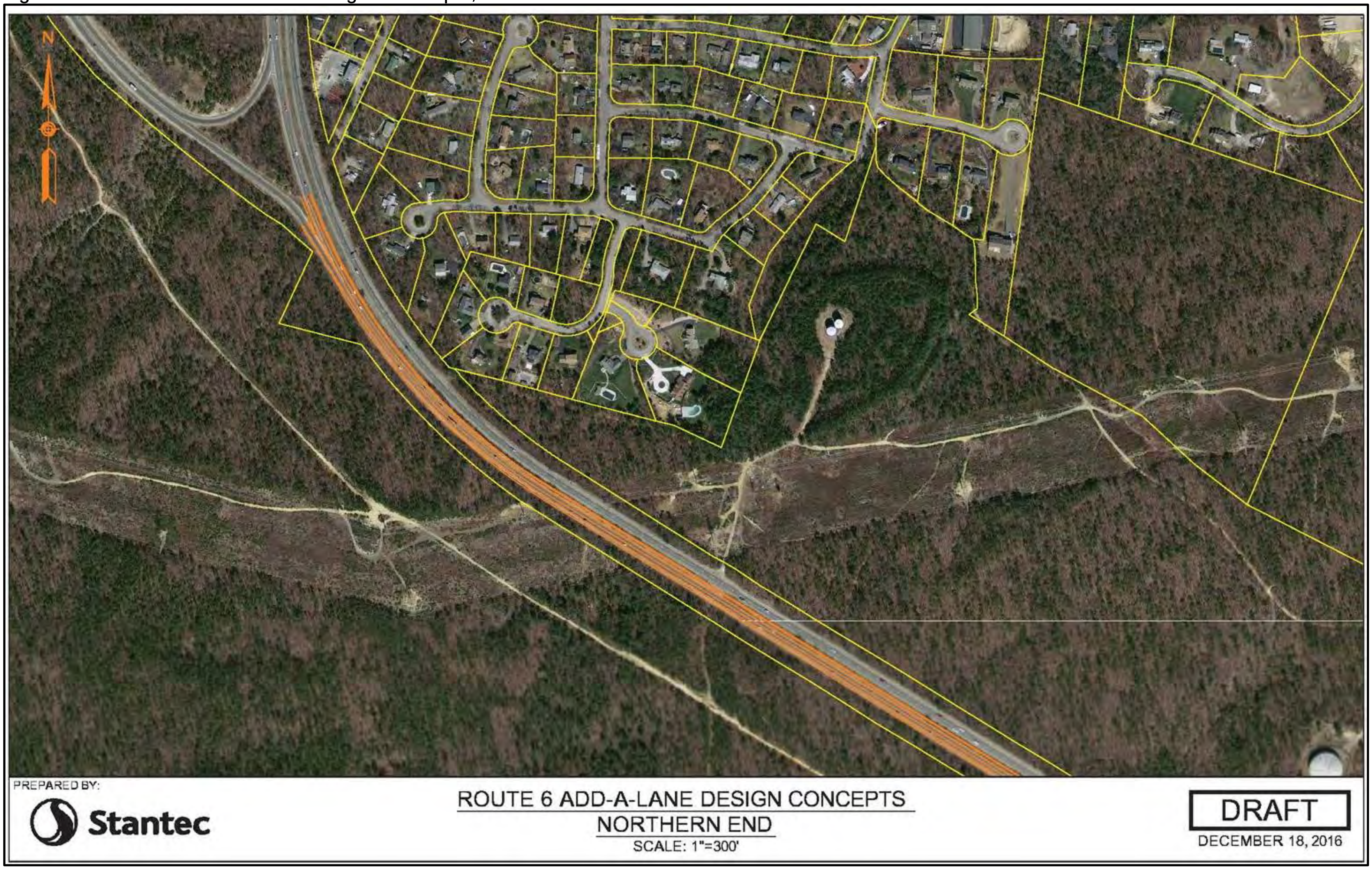


Figure 11. Route 6 Add-a-Lane Design Concepts, Southern End.

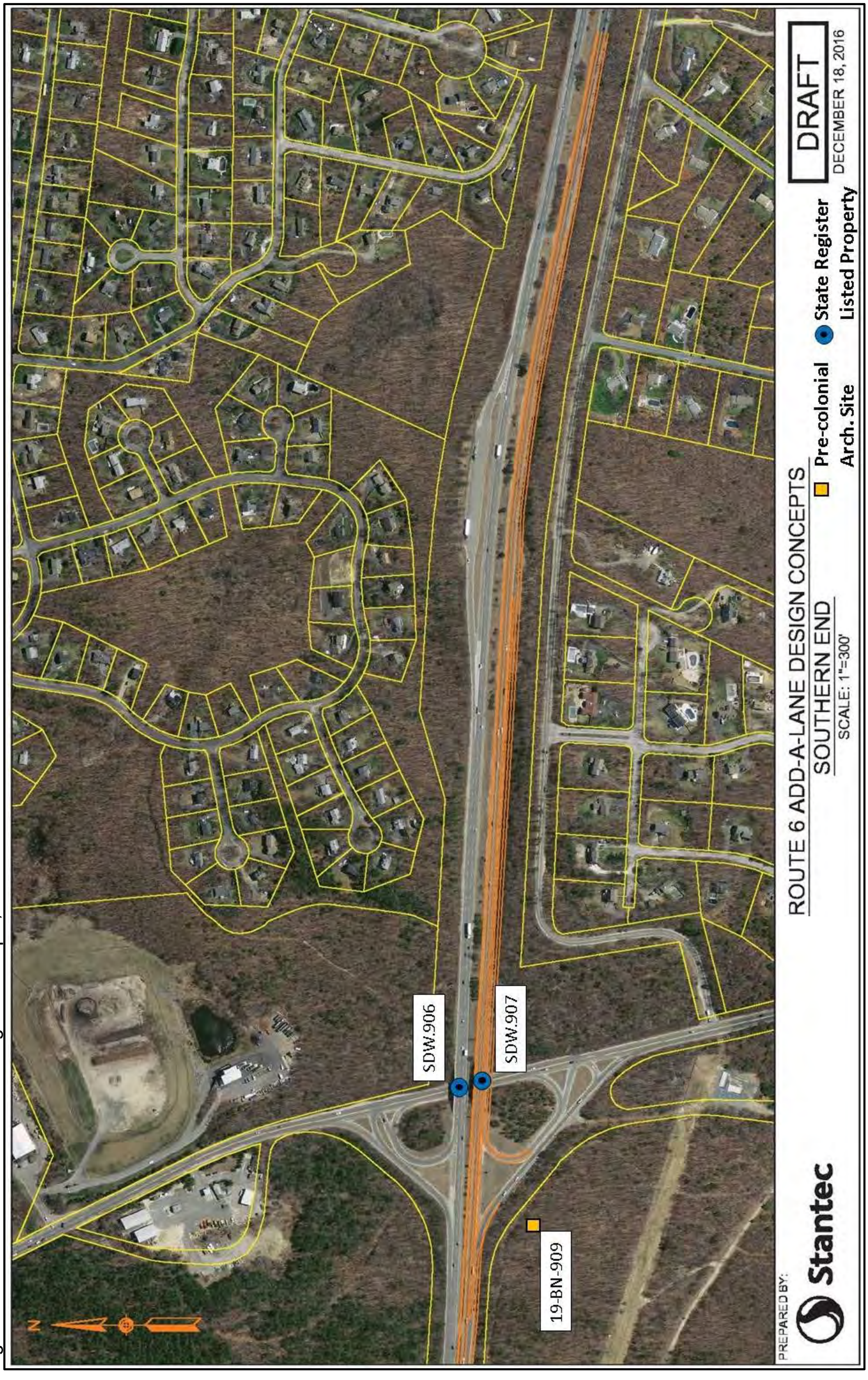


Figure 12. Belmont Circle Design Concepts, Alternative 1.

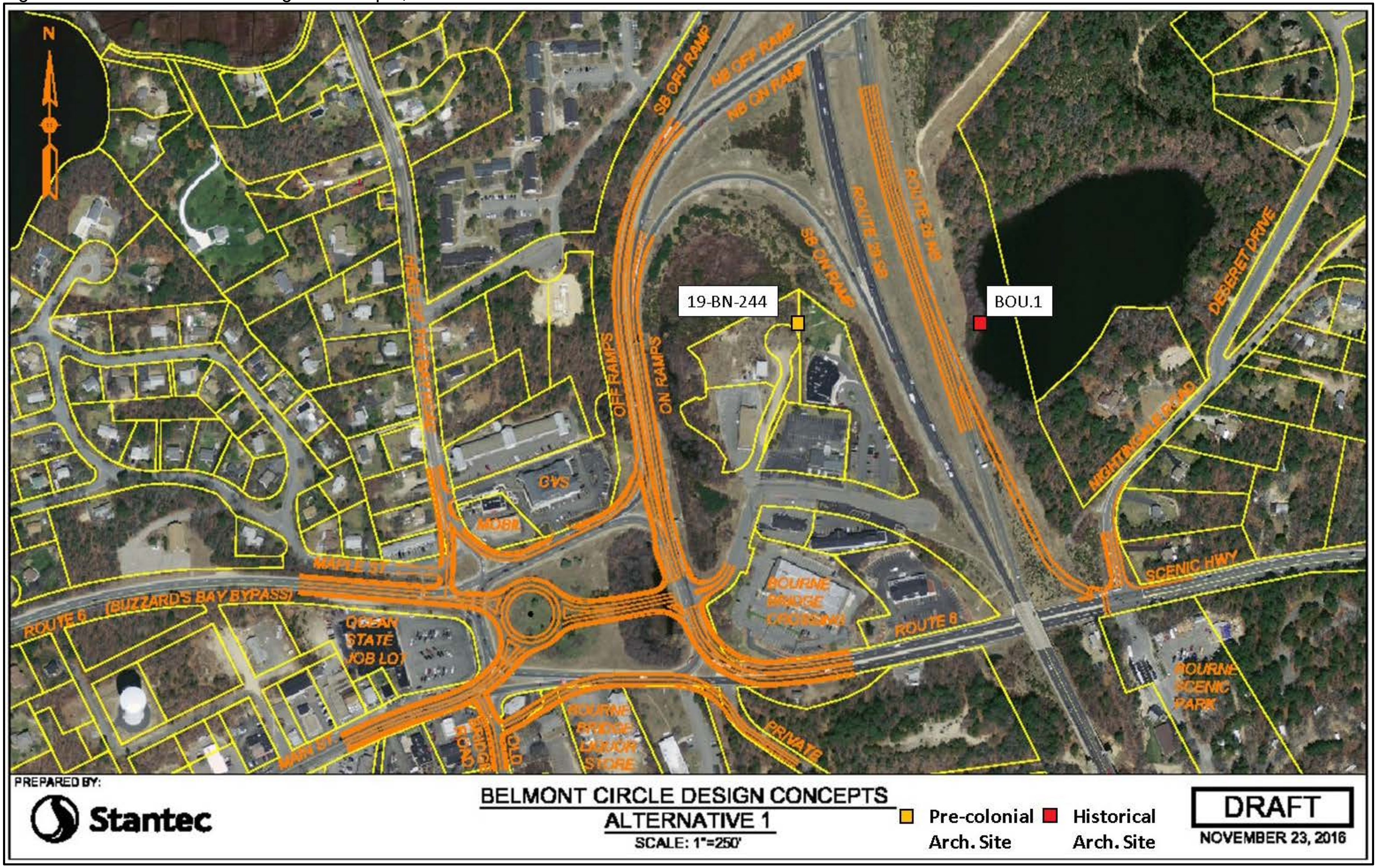
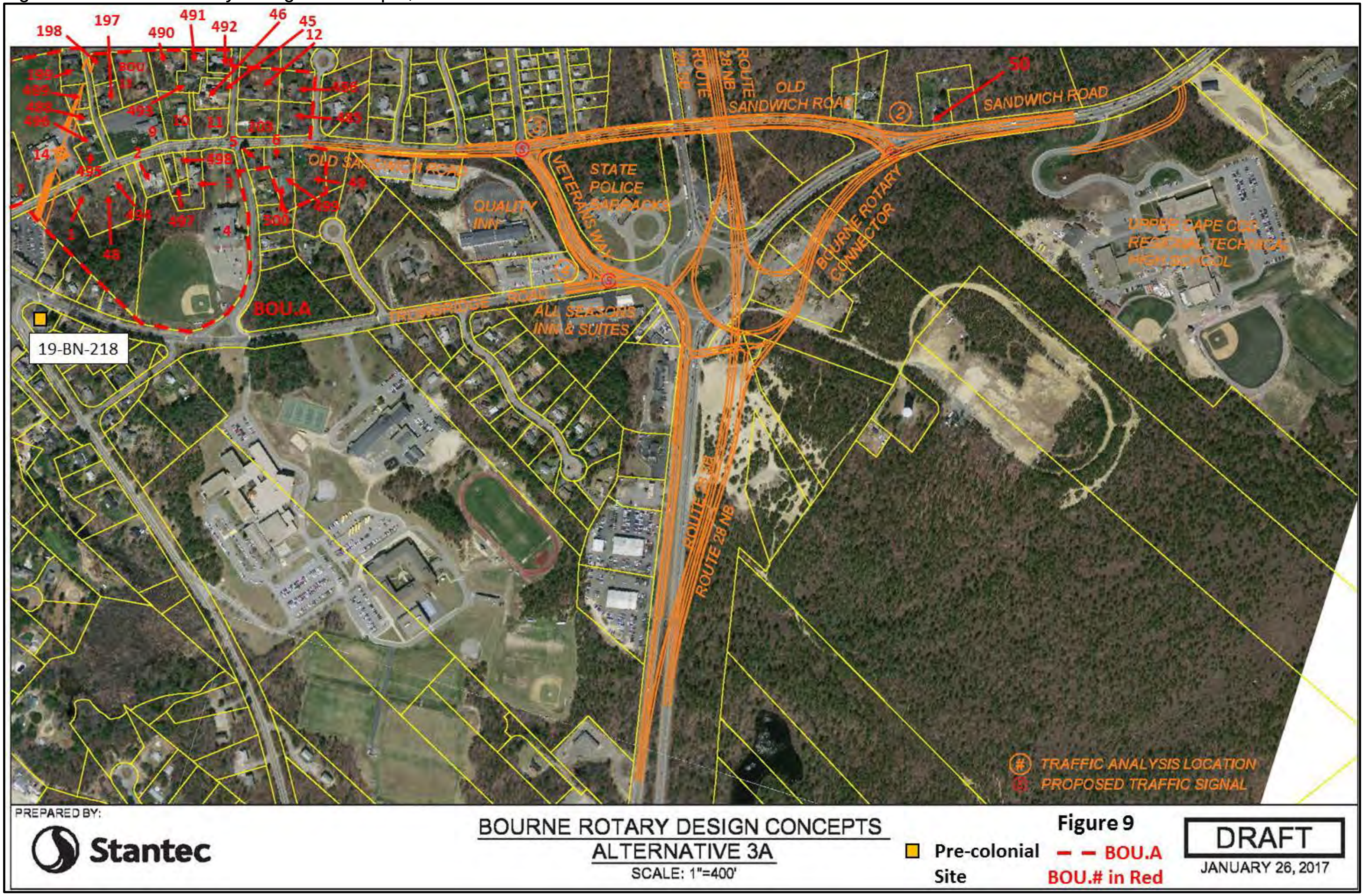


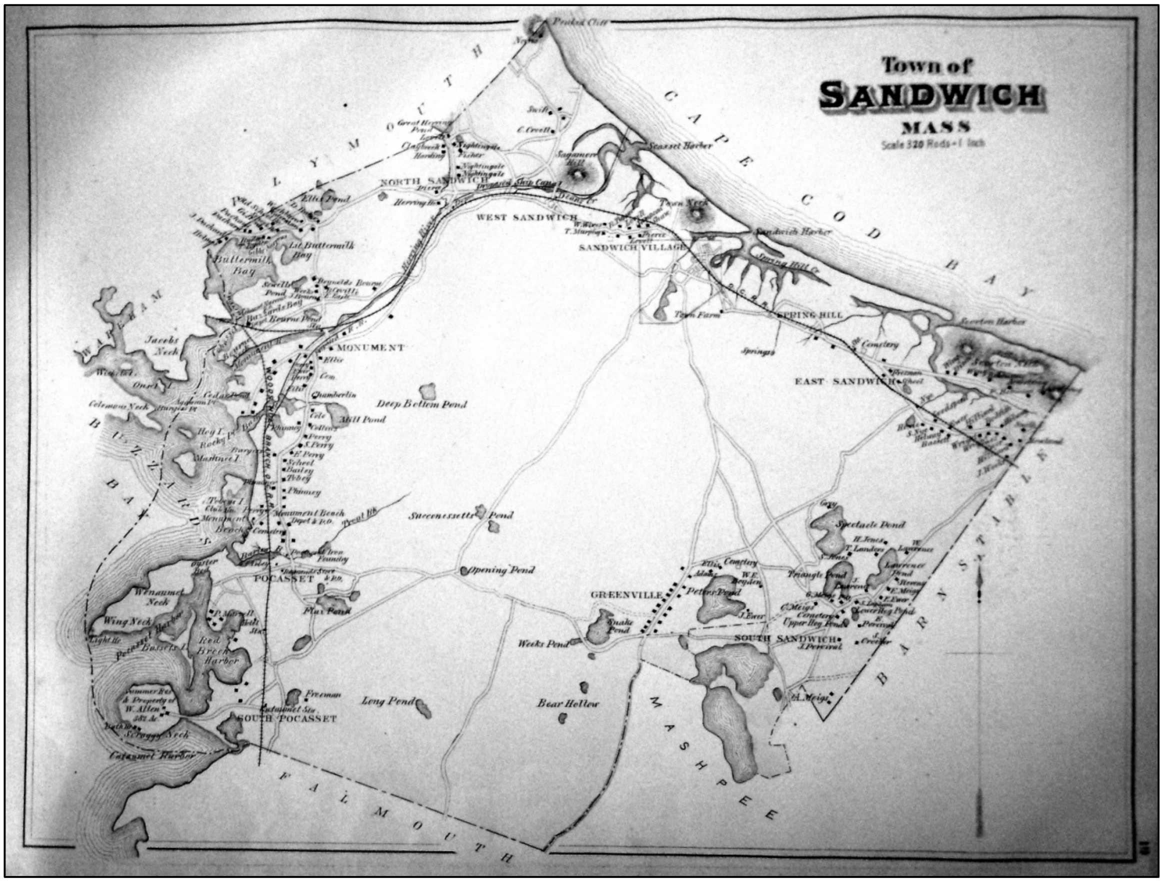
Figure 13. Bourne Rotary Design Concepts, Alternative 2.

Figure 14. Bourne Rotary Design Concepts, Alternative 3A.

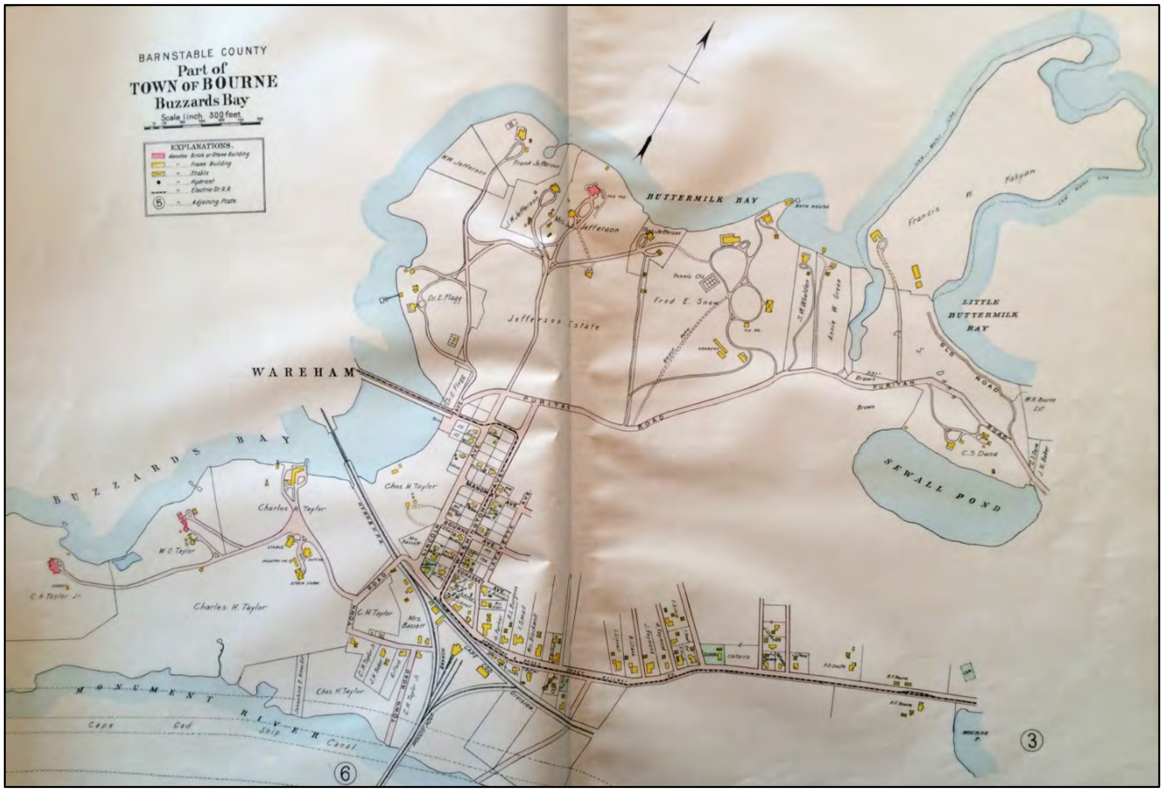


# APPENDIX B: HISTORICAL MAPS


Map 1. Map of the Town of Sandwich, Barnstable County, Mass. by H. F. Walling, 1857.



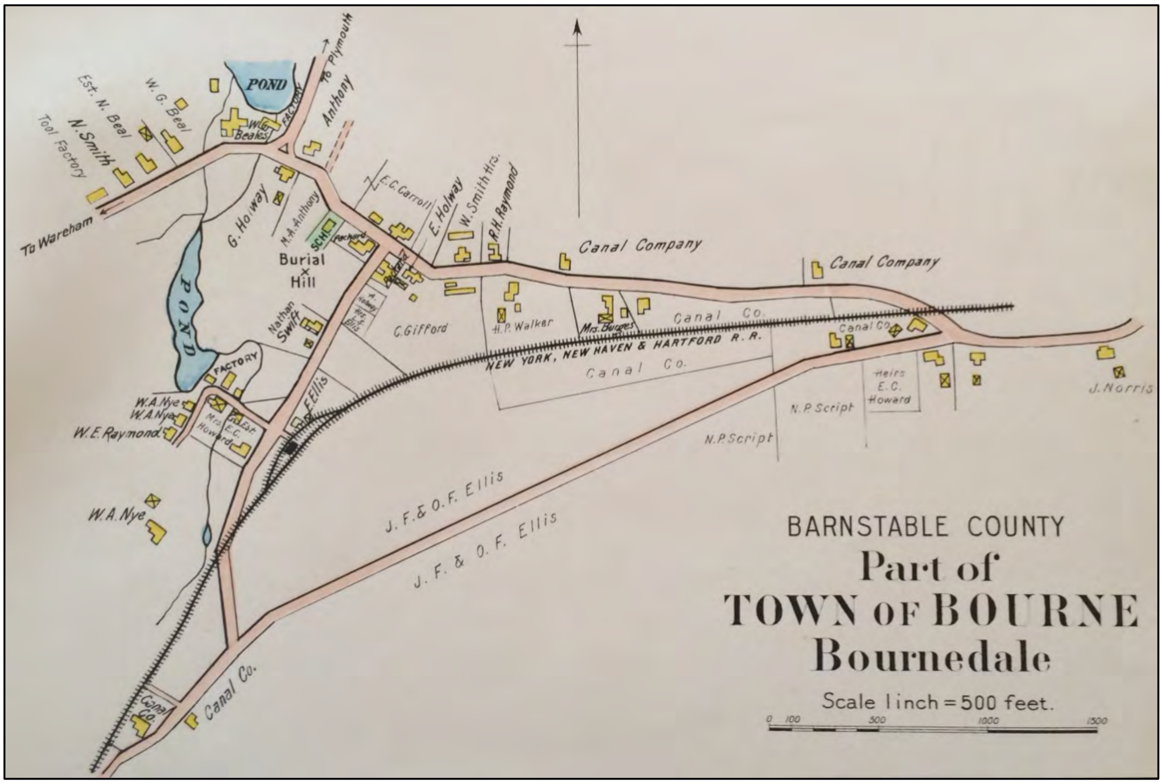

Map 2. Town of Sandwich, Mass. from Atlas of Barnstable County, Massachusetts. Boston, Mass.: Geo. H. Walker & Co., 1880.



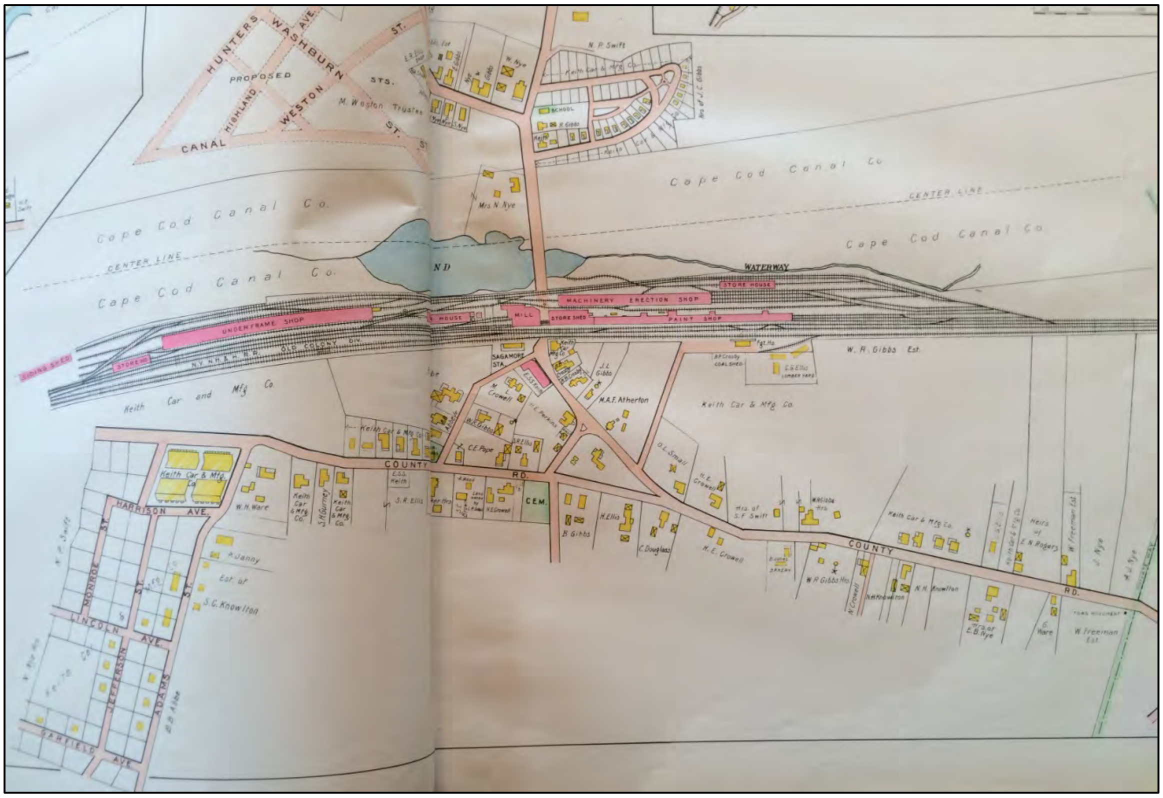

Map 3. Barnstable County: Part of Town of Bourne: Buzzards Bay. Atlas of Barnstable County, Massachusetts. Boston: Walker Lithograph & Publishing, Inc., 1905, page 2.


Map 4. Barnstable County: Part of Town of Bourne. Atlas of Barnstable County, Massachusetts. Boston: Walker Lithograph & Publishing, Inc., 1905, page 3.


Map 5. Indian Hill detail, Herring Brook at Road to Wareham, from A Map of a Survey Across the Isthmus of Cape Cod, State of Massachusetts and Town of Sandwich, of a Proposed Canal Between Buzzard's and Barnstable Bays, 1825. Surveyed under the Direction of Major P. H. Perrault.



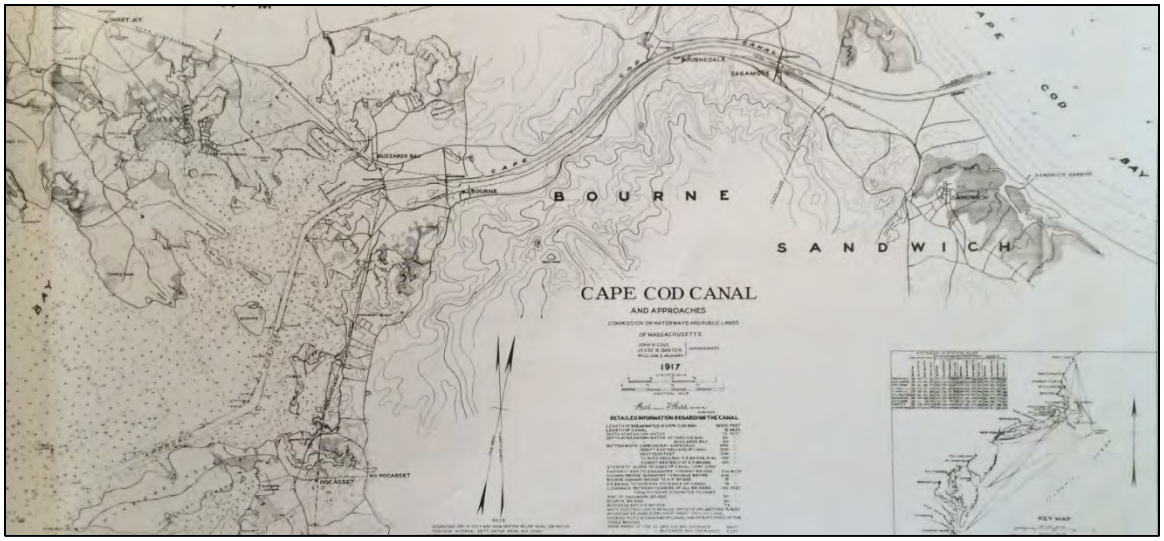

Map 6. Barnstable County: Part of Town of Bourne: Bournedale. Atlas of Barnstable County, Massachusetts. Boston: Walker Lithograph & Publishing, Inc., 1905, page 3. Collection of Bourne Archives, Bourne, Mass.



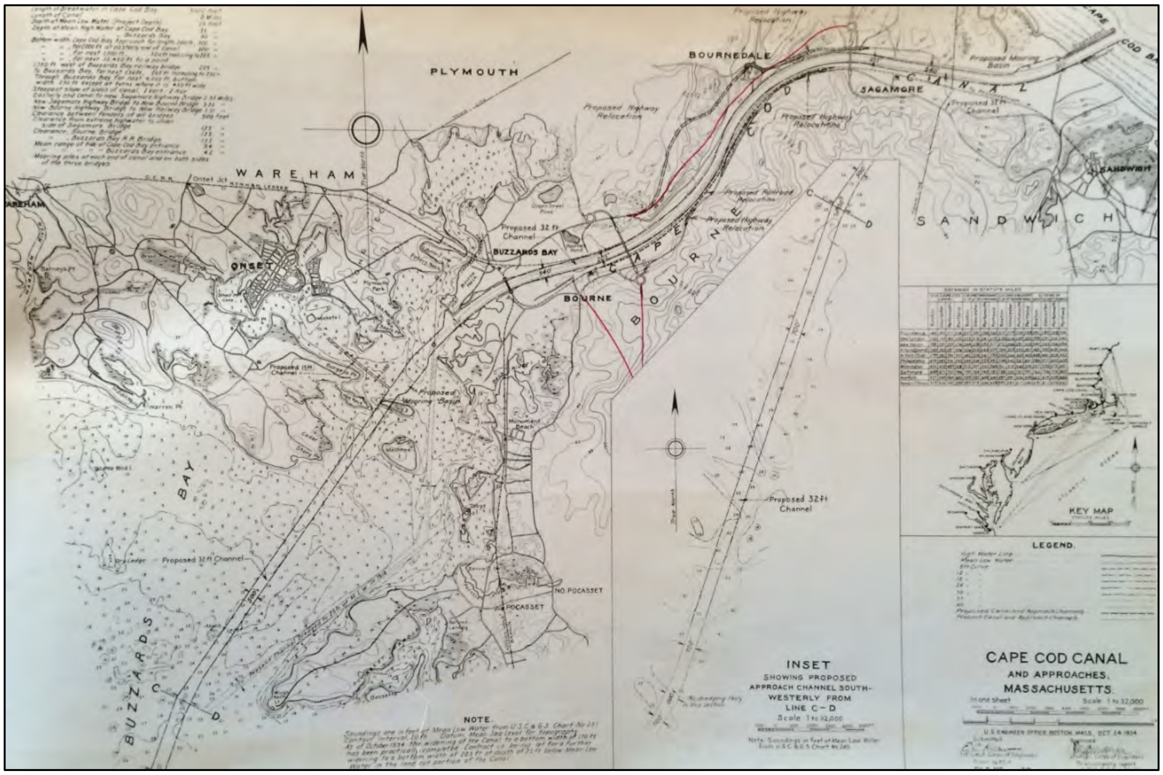

Map 7. Barnstable County: Part of Town of Bourne. Atlas of Barnstable County, Massachusetts. Boston: Walker Lithograph & Publishing, Inc., 1905, page 3.


Map 8. "Machin's Map of a Canal from Barnstable Bay to Buzzard's Bay," 1776.


Map 9. Map of the Route of a Proposed Ship Channel Across Cape Cod from Buzzards Bay to Barnstable Bay. Geo. R. Baldwin and J. G. Chase, 1862.




Map 10. Cape Cod Canal and Approaches, Commission on Waterways and Public Lands, 1917.




Map 11. Cape Cod Canal and Approaches, Massachusetts, U.S. Engineer Office, Boston, 1934.

# APPENDIX C: HISTORICAL IMAGES

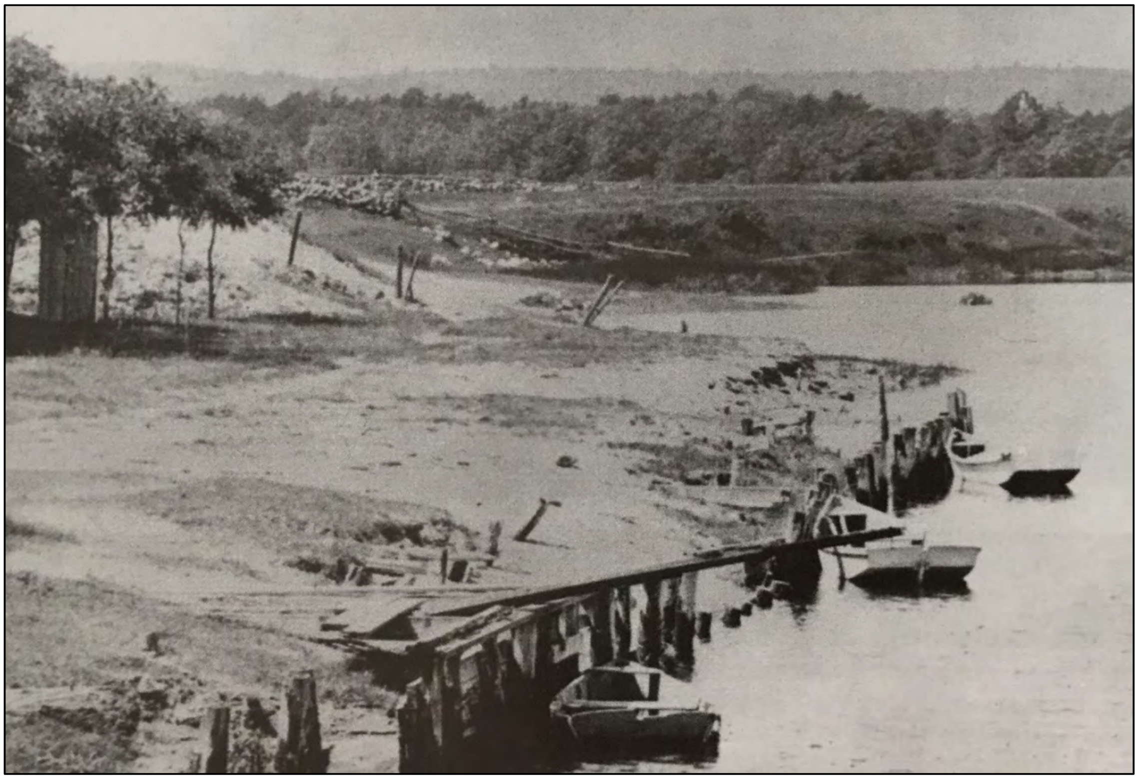


Image 1. View of the Bourne town dock on the Monument River, late 19th century (from Dimock, Bourne, page14).

Image 2. View of Buzzards Bay Rail Road Station (BOU.65) ca. 1912 (from Orwig, Cape Cod Canal, page 51).

Image 3. View of Buzzards Bay Village, late 1920s (from Orwig, Cape Cod Canal, page 105).

Image 4. View of Bourne Village across the Monument River, late 19th century. At left is the Bourne United Methodist Church (BOU.9), next to the Jonathan Bourne Library (BOU.13), and single-family houses (from Dimock, Bourne, page 14).

Image 5. View of Bourne Town Hall (BOU.68; BOU.AE) in Buzzards Bay (from Dimock, Bourne, page 17).

Image 6. View of Keith Car and Manufacturing Company ca. 1910, camera facing southeast. Houses on Savery Avenue are in the foreground (Bourne Historical Society).


Image 7. Bird's eye view of Kings Hi-Way Cabins, a 1930s tourist camp (from Orwig, <u>Cape Cod Canal</u>, page 102).

Image 8. View of excavation of the Monument River at the Collins Farm House, 1912 (from Town of Bourne website historical photos).

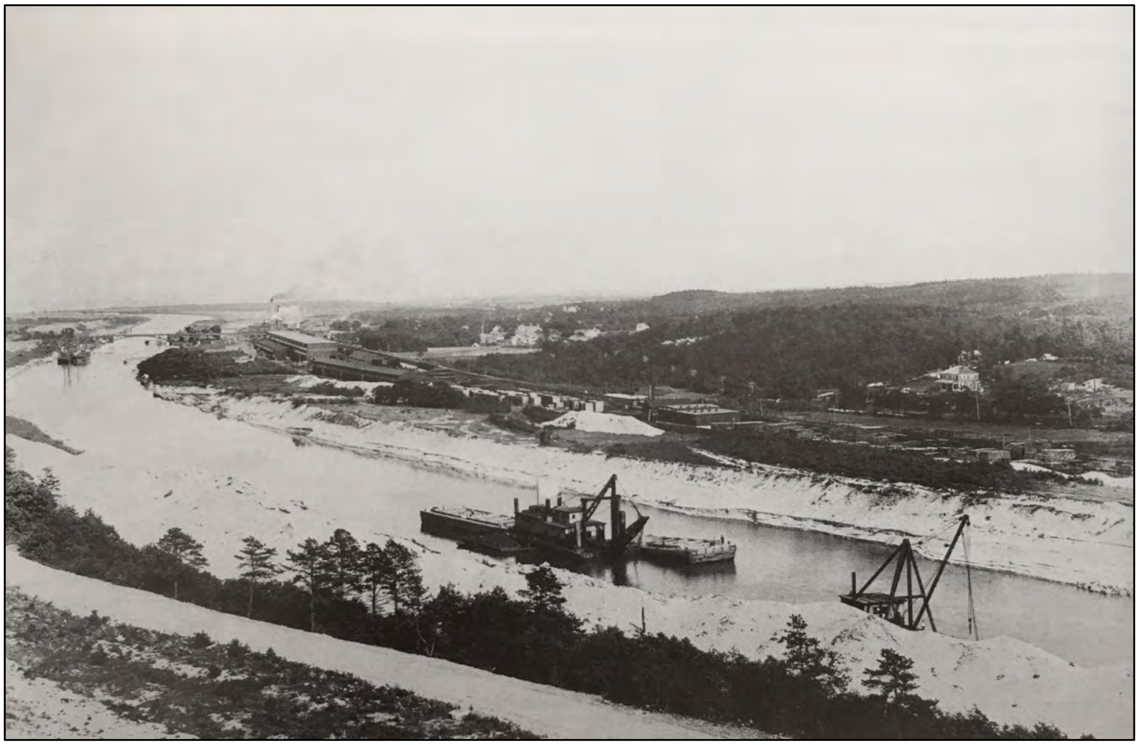


Image 9. View of canal excavation in front of the Keith Car and Manufacturing plant in South Sagamore, ca. 1913 (from Orwig, Cape Cod Canal, p. 115).

Image 10. View of excavation of the Monument River, with two dredges working toward each other, ca. 1912 (from Town of Bourne website historical photos).

Image 11. View of the waters from each end of the new canal meeting after the construction dam was broken through, ca. 1914 (from Town of Bourne website historical photos).

Image 12. View of the completed canal, ca. 1914-16 (from Town of Bourne website historical photos).

Image 13. Aerial view of the Cape Cod Canal, 1936 (from Howard, "Bourne Maps," page 20 (Bourne Historical Society).

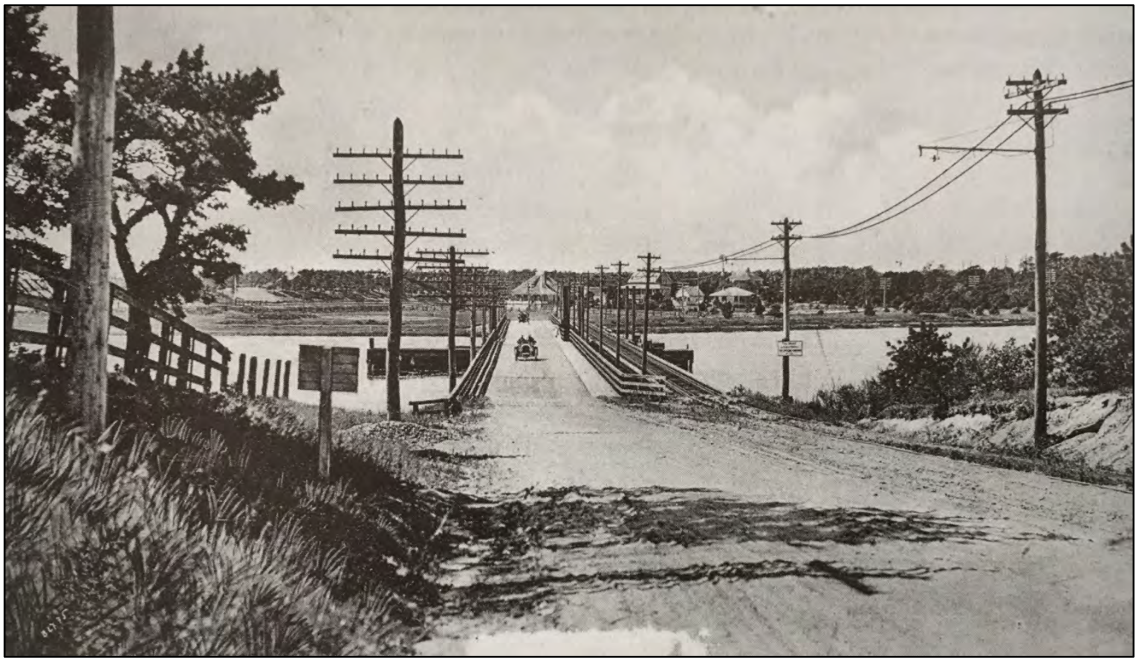


Image 14. Undated view of the 1911 Bourne Highway Bridge (from Orwig, Cape Cod Canal, page 55).


Image 15. Undated view of the 1913 Sagamore Highway Bridge (from Orwig, Cape Cod Canal, page 58).

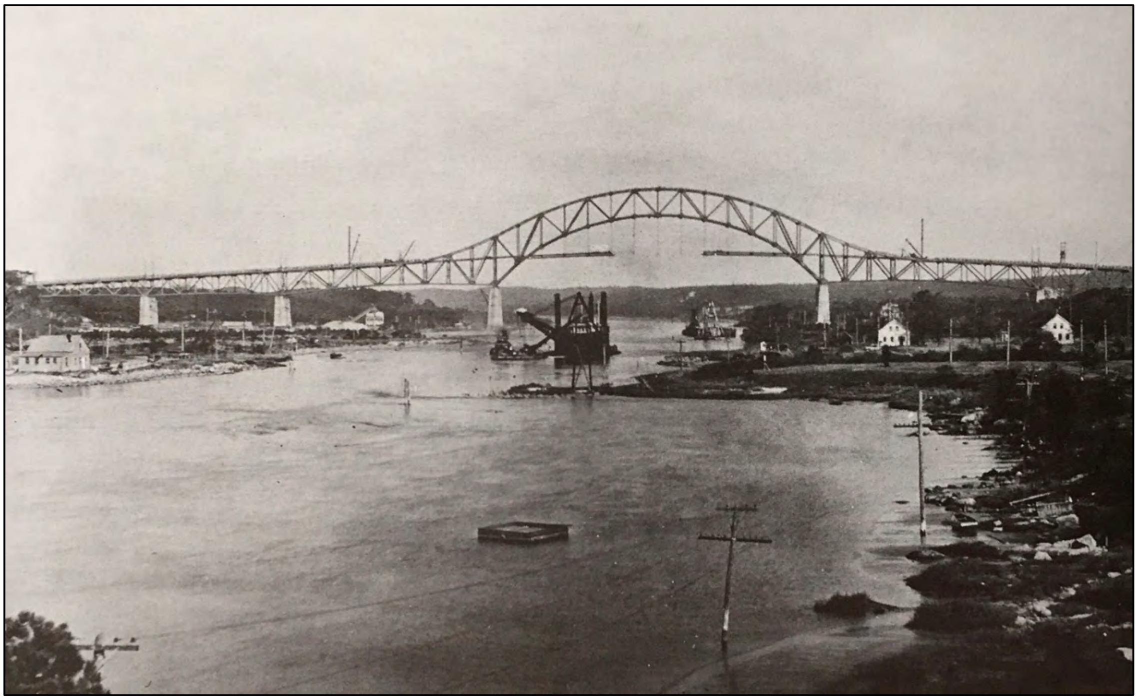


Image 16. View of the Bourne Bridge under construction, ca. 1933-1934 (from Orwig, Cape Cod Canal, page 108).


Image 17. View of the Sagamore Bridge under construction ca. 1933-1934 (from Orwig, Cape Cod Canal, page 113).

Image 18. View of the Bourne Bridge at completion, 1935 (from Orwig, Cape Cod Canal, page 124).

Image 19. View of the Sagamore Bridge at completion, 1935. The canal was widened after the new bridges were completed (from Orwig, Cape Cod Canal, page 115).

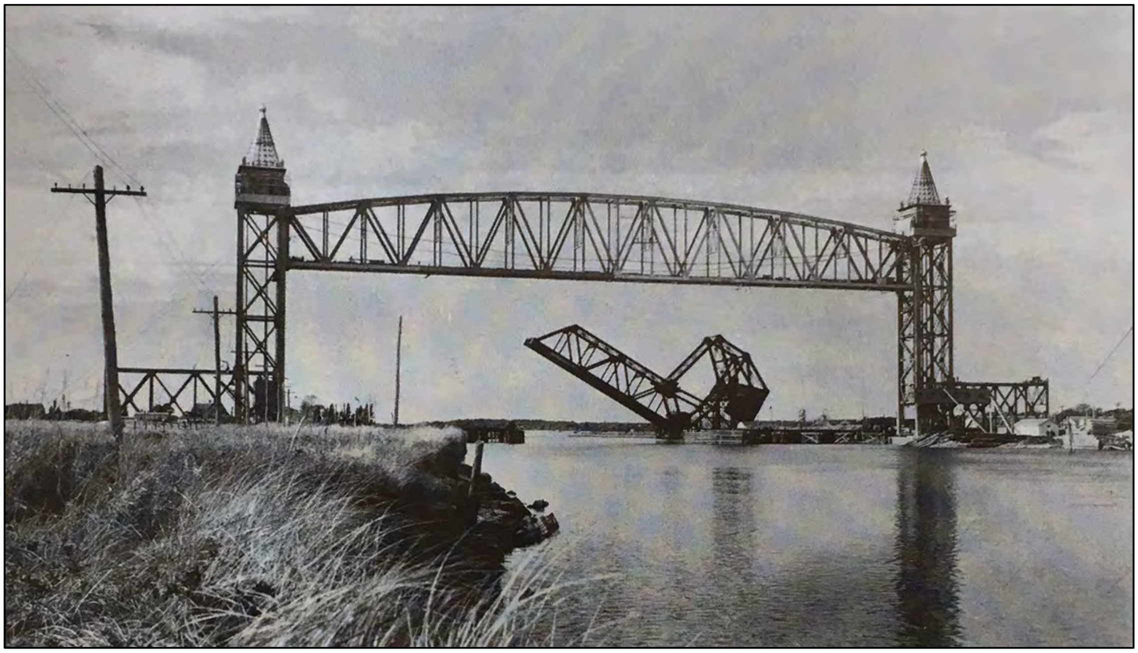


Image 20. View of the Buzzards Bay Railroad Bridge at completion, 1935 (from Orwig, Cape Cod Canal, page 117).

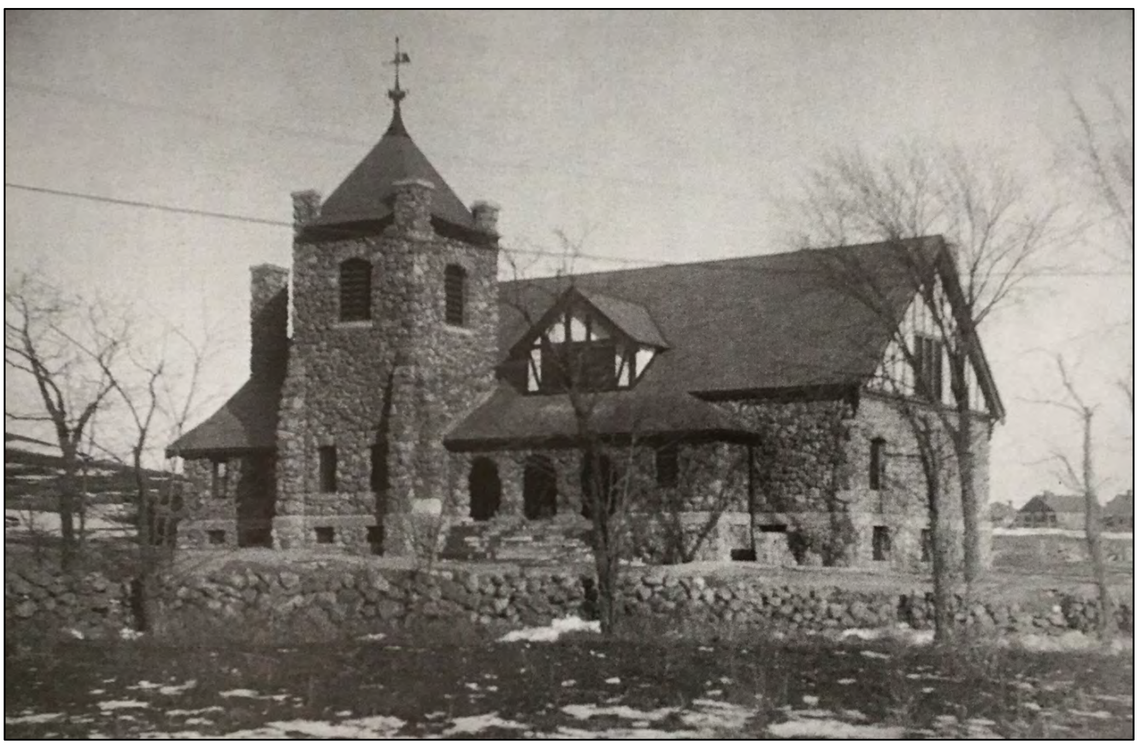


Image 21. Swift Memorial Church (BOU.118) in North Sagamore ca. 1910 (from Dimock, Bourne, page18).

Image 22. View of Keith Car and Manufacturing Company worker housing on Savery Avenue (BOU.P) in North Sagamore (from Orwig, Cape Cod Canal, page 15).

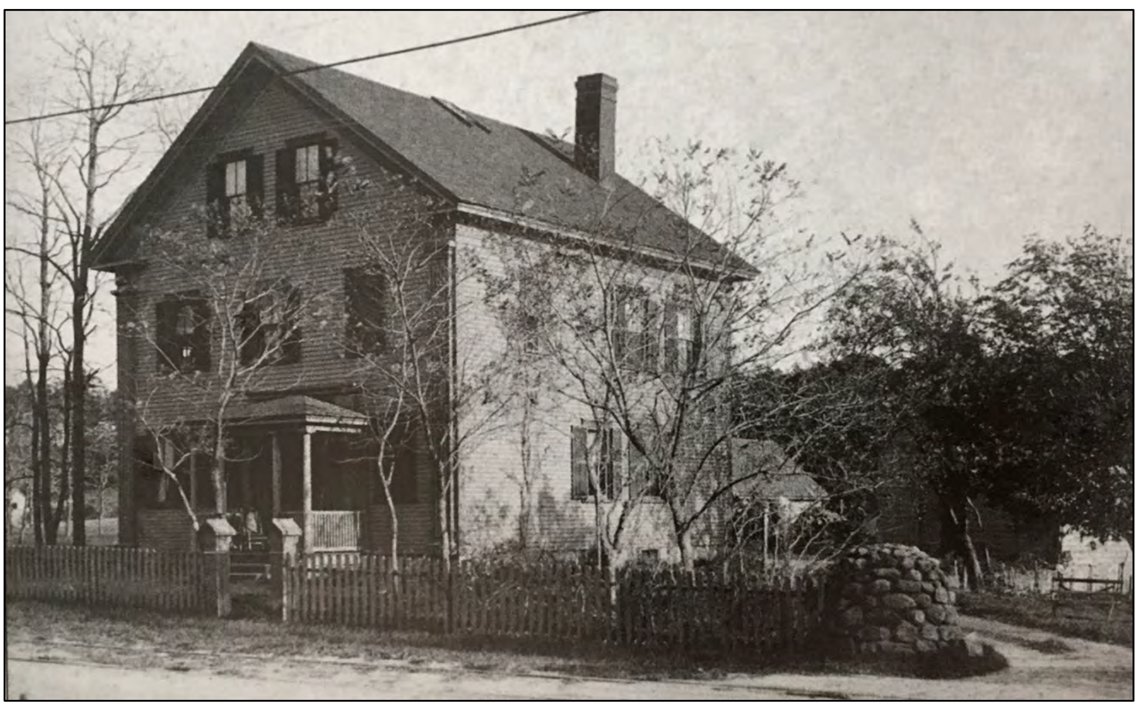


Image 23. View of the George I. Briggs House (BOU.1) in Bourne Village, early 20th century (from Dimock, Bourne, p. 30).

# APPENDIX D: PHOTOGRAPHS

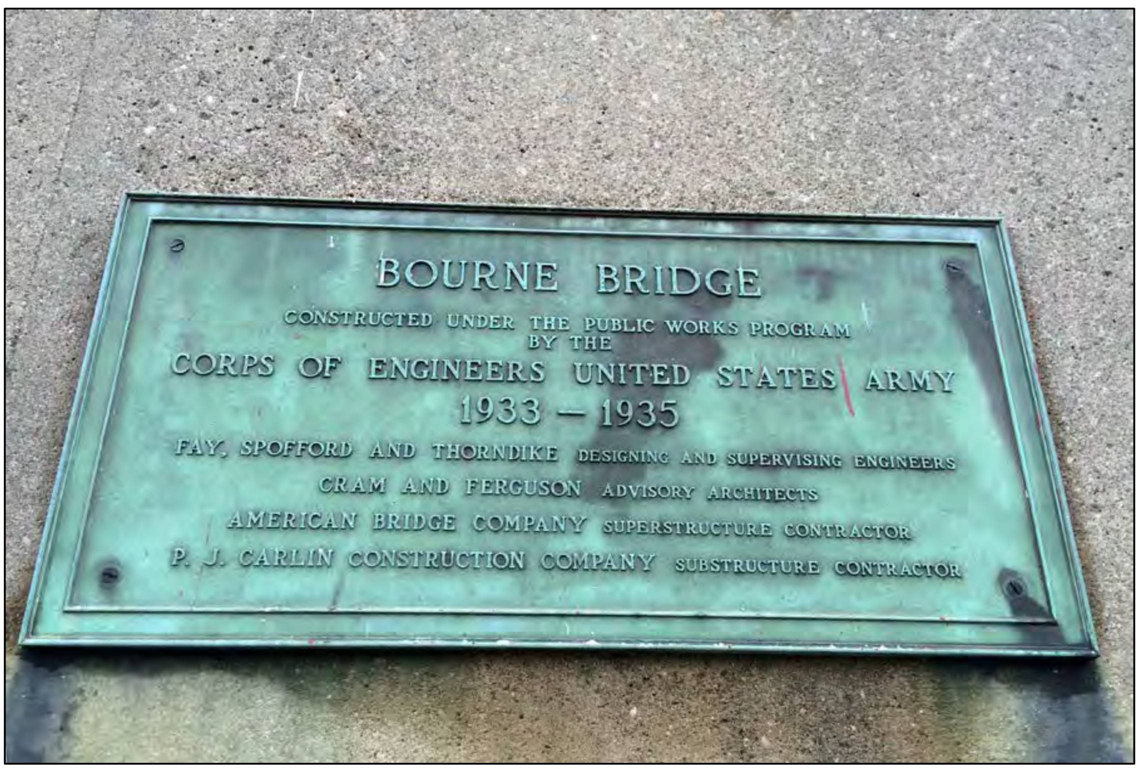
Photograph 1. Cape Cod Canal (BOU.AF; BOU.937), view from Cape-side mid canal overlook, camera facing northwest.

Photograph 2. Cape Cod Canal (BOU.AF; BOU.937), view from canal path near Bourne Village, camera facing northeast.

Photograph 3. Cape Cod Canal (BOU.AF; BOU.937) & Sagamore Bridge, view from the Quartz Marker (BOU.939), camera facing east.

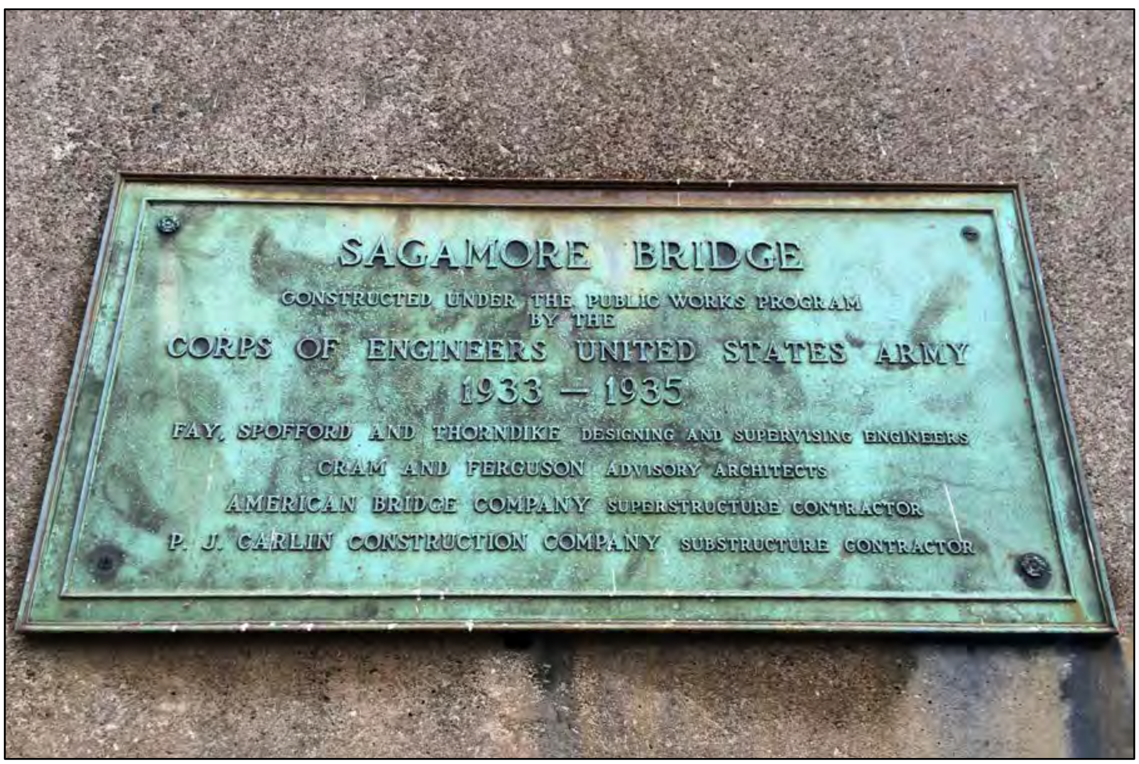
Photograph 4. Quartz Marker (BOU.939 camera facing southeast.

Photograph 5. Bourne Bridge (BOU.919) and Railroad Bridge (BOU.901) in background, camera facing southwest.




Photograph 6. Bourne Bridge plaque, camera facing west.

Photograph 7. Cape Cod Canal and Sagamore Bridge (BOU.918), view from the Quartz Marker( BOU.939), camera facing northeast.




Photograph 8. Sagamore Bridge plaque, camera facing east.

Photograph 9. Buzzards Bay Vertical Lift Railroad Bridge (BOU.901), camera facing southwest.

Photograph 10. Capt. Sylvanus Gibbs House (BOU.29) on Head of the Bay Road, camera facing northeast.

Photograph 11. Gibbs House (BOU.60) at 295 (formerly 291) Head of the Bay Road, camera facing southwest.

Photograph 12. Head of the Bay Cemetery(BOU.803)on Head of the Bay Road, camera facing southwest.

Photograph 13. Buzzards Bay Rail Road Station (BOU.65) on Main Street, camera facing northeast.

Photograph 14. Buzzards Bay Rail Road Station & Tower (BOU.65, 66) on Main Street, camera facing northeast.

Photograph 15. Bourne Town Hall (BOU.AE; BOU.68) at 24 Perry Avenue, camera facing northeast.

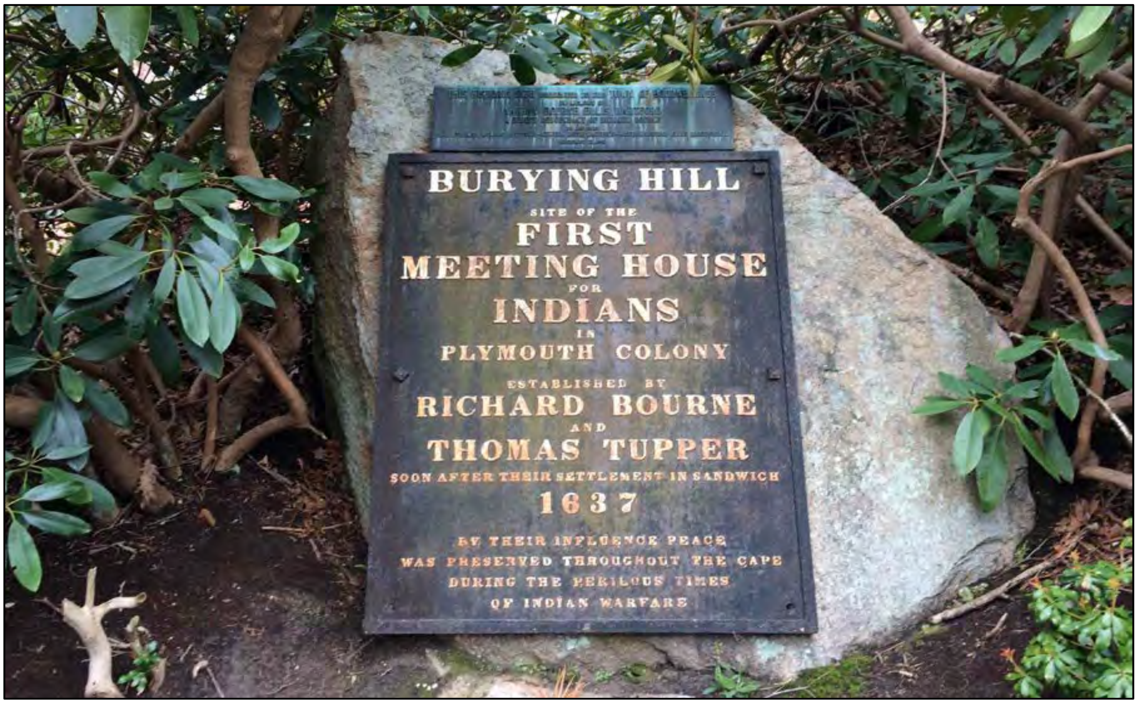
Photograph 16. Massachusetts Army National Guard Armory (BOU.388) at 10 Armory Road, camera facing northeast.

Photograph 17. Abram F. Swift House (BOU.67) at 37 Old Bridge Street, camera facing northwest.

Photograph 18. First Bourne Bridge Abutment (BOU.943), camera facing west.

Photograph 19. Cape Cod Canal Electrical Substation (BOU.389), camera facing northeast.


Photograph 20. Burying Hill (BOU.920) on Old Herring Pond Road, camera facing northwest.




Photograph 21. Burying Hill plaque(BOU.920) on Old Herring Pond Road, camera facing northwest.

Photograph 22. Herring Run (BOU.921) at Old Herring Pond Road, camera facing south.

Photograph 23. Herring Fish Ladder (BOU.938) at Route 6 east, camera facing southwest.

Photograph 24. Village School (BOU.57) at 29 Herring Pond Road, camera facing south.

Photograph 25. Wilson D. Bent, Sr. House (BOU.55) at 9 Bournedale Road, camera facing south.

Photograph 26. Josiah Ellis House (BOU.209, 210) at 166 Herring Pond Road, camera facing east.


Photograph 27. Nathan Bourne Ellis House/Bournedale Lodge (BOU.211) at 854 Route 6, camera facing northwest.

Photograph 28. Mason White/Battles House (BOU.54) at 6 Bournedale Road, camera facing north.

Photograph 29. Indian Cemetery (BOU.800; PLY.800) on Little Sandy Pond Road, camera facing northwest.

Photograph 30. Swift Memorial Church (BOU.118) at 10 Williston Road, camera facing northeast.

Photograph 31. Sagamore Grammar School (BOU.119) at 30 Williston Road, camera facing southeast.

Photograph 32. Capt. William Crowell Gibbs House (BOU.283, 281) on Old Plymouth Road, camera facing southeast.

Photograph 33. Keith Company houses (BOU.123, 124, 125) on Savery Avenue, camera facing northeast.

Photograph 34. Keith Company houses (BOU.130 to 134) on Savery Avenue, camera facing east.

Photograph 35. Crowell Farm (BOU.27) at 31 Crowell Road, camera facing northwest.

Photograph 36. Assembly Hall (BOU. 175) at 30 Robinson Road, camera facing southeast.

Photograph 37. Rev. William E. Wolcott House (BOU.323) at 39 Robinson Road, camera facing northwest.

Photograph 38. Sagamore Hill Gun Battery (SDW.AA) in Scusset Beach State Reservation, camera facing northeast.

Photograph 39. George I. Briggs House (BOU.1) at 22 Sandwich Road, camera facing east.


Photograph 40. Jonathan Bourne Historic Center (BOU.13) at 30 Keene Street, camera facing south.

Photograph 41. Bourne High School (BOU.4) at 85 Cotuit Road, camera facing south.

Photograph 42. Arabella Parker-George Ellis House (BOU.49) at 66 Sandwich Road (red house); Arabella Ellis Parker House (BOU.6) at 60 Sandwich Road; Moses Dagget House (BOU.5) at 56 Sandwich Road, camera facing southeast.

Photograph 43. Moses C. Waterhouse House (BOU.12) at 59 Keene Street, camera facing northeast.

Photograph 44. Ordello R. Swift House (BOU.45) at 60 Keene Street, camera facing northwest.

Photograph 45. Alonzo Booth Blacksmith Shop (BOU.48) at 22 Sandwich Road, camera facing southeast.

Photograph 46. Jonathan Bourne Public Library (old Bourne Grammar Schoo)l (BOU.14) at 19 Sandwich Road, camera facing northwest.

Photograph 47. Albert E. Eldridge House (BOU.10, 202) at 43 Sandwich Road, camera facing northwest.

Photograph 48. Deacon Gershom Ellis/Henry S. Blackwell House (BOU.50) at 201 Sandwich Road, camera facing northwest.

Photograph 49. 2 Shore Road (BOU.411, BOU.410), camera facing northeast.

Photograph 50. 10 Shore Road (BOU.412, BOU.413), camera facing northwest.

Photograph 51. 18 Shore Road (BOU.414), camera facing northwest.

Photograph 52. 19 Shore Road (BOU.415), camera facing southwest.

Photograph 53. Rev. Herman Perry House (BOU.51) at 7 Shore Road, camera facing southeast.

Photograph 54. Aptucxet Trading Post (BOU.32) at 24 Aptucxet Road, camera facing northwest.

Photograph 55. 2 County Road (BOU.450), camera facing southwest.

Photograph 56.122 County Road (BOU.481.482), camera facing southwest.

Photograph 57. Deacon Elijah Perry House (BOU.43) at 203 County Road, camera facing southeast.

Photograph 58. Burgess Homestead (BOU.177) on 11 Burgess Street, camera facing northwest.

Photograph 59. Isaac N. Keith House (BOU.184,185) at 66 Pleasant Street, camera facing south.

Photograph 60. Samuel H. Gurney House and Variety Store (BOU.186) at 896 Sandwich Road, camera facing southeast.

Photograph 61. S. Harlow/Benjamin Harlow Pope House (BOU.188) at 941 Sandwich Road, camera facing northwest.

Photograph 62. Crowell/Hannah Rebecca Burgess House (BOU.192) at 1005 Sandwich Road, camera facing north.

Photograph 63. C.G Ellis House (BOU.344) at 1071 Sandwich Road, camera facing north.

Photograph 64. Rogers House (BOU.345) at 1085 Sandwich Road, camera facing northwest.

Photograph 65. Freeman Farm Foreman's House (BOU.194, 195) at 1101 Sandwich Road, camera facing northwest

Photograph 66. 38 and 32 Commonwealth Avenue, camera facing southeast.

Photograph 67. 5 and 9 Adams Street and Keith Car Company Apartments (BOU.328) at 860 Sandwich Street, camera facing south.

Photograph 68. 22 and 20 Westdale Park Road, camera facing northwest.

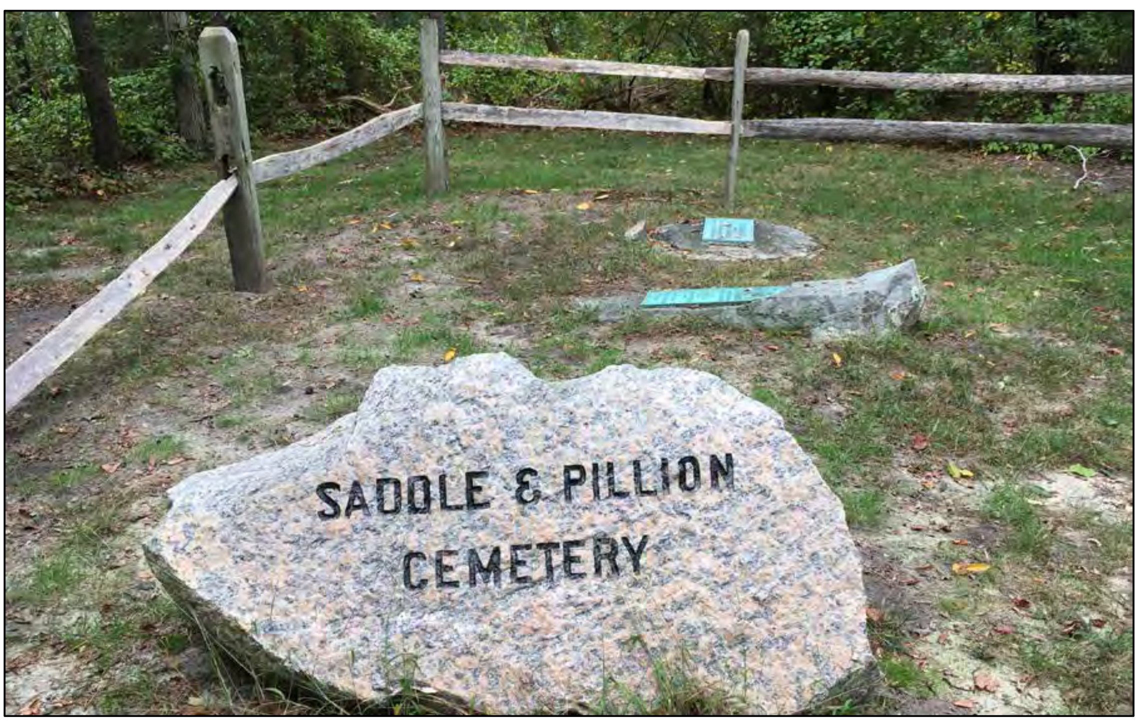
Photograph 69. 18, 16 and 10 Pleasant Street, camera facing northeast.

Photograph 70. Searle-Davis House (SDW.570) at 41 Shawme Road, camera facing south.

Photograph 71. Route 6 bridges (SDW.907 and 906) at interchange with Route 130, camera facing northwest.

Photograph 72. Motor Court (SDW.495) at 14 Sandwich Road, camera facing southwest.

Photograph 73. Motor Court (SDW.489) at 27 Sandwich Road, camera facing northwest.




Photograph 74. Saddle and Pillion Burial Ground (SDW.802) at 6 Tupper Road, camera facing northeast.

Photograph 75. 8 Main Street (SDW.504), camera facing southwest.

Photograph 76. 12 Main Street (SDW.505), camera facing south.

# APPENDIX E: TABLES

Table 1. Historic Status of MHC-Inventoried Resources

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed |
|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | |
| BOU.918 | Bourne Bridge | | X | | | |
| BOU.919 | Sagamore Bridge | | X | | | |
| BOU.AF | Cape Cod Canal | | | X | | |
| SDW.Z | Cape Cod Canal | | | X | | X |
| NORTH OF CANAL | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | |
| BOU.C | Head of the Bay | | | | 1 | |
| BOU.I | Bournedale | 1 | | | 3 | |
| BOU.J | Main Street Commercial Area | | | | 2 | |
| BOU.O | North Sagamore | | | | 3 | |
| BOU.P | Savery Avenue | | | | | |
| BOU.U | Sagamore Beach | | | | 3 | |
| BOU.AE | Bourne Town Hall | 1 | | | | X |
| PLY.G | Cedarville | | | X | | |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X |
| SOUTH OF CANAL | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | |
| BOU.AG | Aptucxet Trading Post | | | X | | |
| BOU.AH | Shore Road North | | | | 1 | |
| BOU.AJ | County Road North | | | | 1 | |
| BOU.V | South Sagamore | | | X | 8 | |
| SDW.906 | Route 6 Bridge | | | | | X |
| SDW.907 | Route 6 Bridge | | | | | X |
| SDW.F | Shawme Road | | | X | | X |
| SDW.G | Route 6A West | | | | | X |
| SDW.I | Main Street | | | | | X |
| SDW.R | Old Kings Highway Regional HD | | | | | X |

Table 2. Potential Middle Bridge 1 Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | Direct/Indirect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | Indirect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 3. Potential Middle Bridge 2 Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | Direct/Indirect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | Direct/Indirect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 4. Potential Sandwich Road Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 5. Potential Relocated Exit 1 Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | Direct/Indirect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | Indirect |
| SDW.I | Main Street | | | | | X | Indirect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | Indirect |

Table 6. Potential Route 3 to Route 25 Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Stantec

Table 7. Potential Scenic Highway Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | Indirect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | Direct/indirect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 8. Potential Sagamore Twin Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | Direct |
| BOU.AF | Cape Cod Canal | | | X | | | Direct/Indirect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | Indirect |
| BOU.P | Savery Avenue | | | | | | Indirect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | Indirect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 9. Potential New Route 6 EB Travel Lane Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | Indirect |
| SDW.907 | Route 6 Bridge | | | | | X | Direct |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

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Table 10. Potential Bourne Bridge Replacement & Immediate Approaches Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | Direct |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | Direct/Indirect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 11. Potential Belmont Circle & Scenic Highway to Route 25 Ramp Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | No adverse effect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

Table 12. Potential Bourne Rotary Alternative 2 Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | Direct/Indirect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

HISTORIC RESOURCES EVALUATION

Appendix A
May 18, 2017

Table 13. Potential Bourne Rotary Alternative 3A Effects

| MHC ID | Name | NR (# of Ind Prop) | NR Eligible per MHC | NR Pot. Eligible (District) | NR Pot. Eligible (# of Ind Prop) | SR Listed | Potential Effects |
|---|---|---|---|---|---|---|---|
| CAPE COD CANAL | | | | | | | |
| BOU.919 | Bourne Bridge | | X | | | | No adverse effect |
| BOU.918 | Sagamore Bridge | | X | | | | No adverse effect |
| BOU.AF | Cape Cod Canal | | | X | | | No adverse effect |
| SDW.Z | Cape Cod Canal | | | X | | X | No adverse effect |
| NORTH OF CANAL | | | | | | | |
| BOU.388 | Mass. Army NG Armory | | X | | | | No adverse effect |
| BOU.C | Head of the Bay | | | | 1 | | No adverse effect |
| BOU.I | Bournedale | 1 | | | 3 | | No adverse effect |
| BOU.J | Main Street Commercial Area | | | | 2 | | No adverse effect |
| BOU.O | North Sagamore | | | | 3 | | No adverse effect |
| BOU.P | Savery Avenue | | | | | | No adverse effect |
| BOU.U | Sagamore Beach | | | | 3 | | No adverse effect |
| BOU.AE | Bourne Town Hall | 1 | | | | X | No adverse effect |
| PLY.G | Cedarville | | | X | | | No adverse effect |
| SDW.AA | Sagamore Hill Gun Battery | | | X | | X | No adverse effect |
| SOUTH OF CANAL | | | | | | | |
| BOU.A | Keene St - Sandwich Rd Area | 3 | | X | 6 | | Direct/Indirect |
| BOU.B | Cape Cod Air Station - Otis AFB | | | | | | No adverse effect |
| BOU.AG | Aptucxet Trading Post | | | X | | | No adverse effect |
| BOU.AH | Shore Road North | | | | 1 | | No adverse effect |
| BOU.AJ | County Road North | | | | 1 | | No adverse effect |
| BOU.V | South Sagamore | | | X | 8 | | No adverse effect |
| SDW.906 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.907 | Route 6 Bridge | | | | | X | No adverse effect |
| SDW.F | Shawme Road | | | X | | X | No adverse effect |
| SDW.G | Route 6A West | | | | | X | No adverse effect |
| SDW.I | Main Street | | | | | X | No adverse effect |
| SDW.R | Old Kings Highway Regional HD | | | | | X | No adverse effect |

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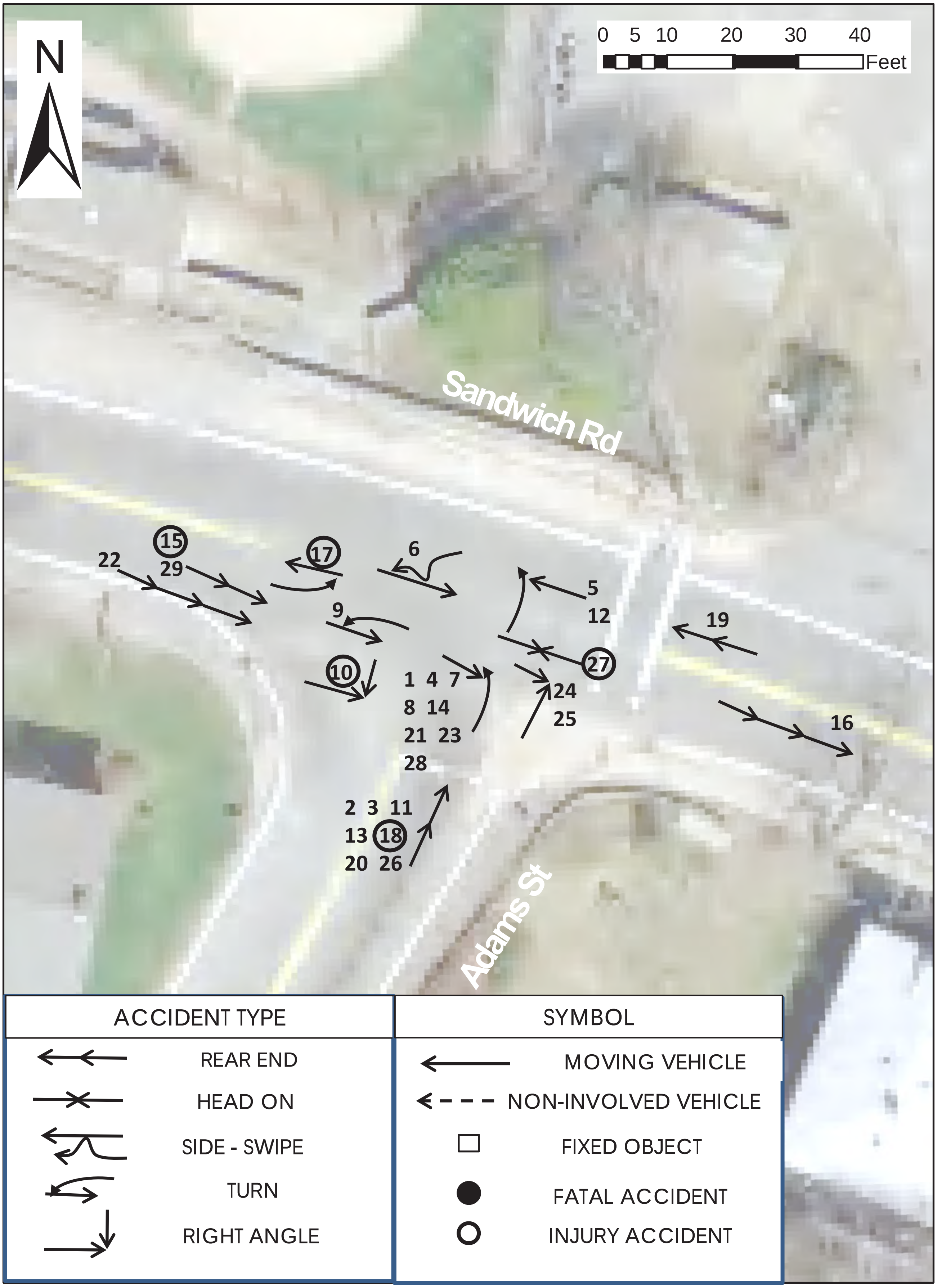
Table 14. Potential Effects to Archaeological and Cultural Resources

| Potential Roadway Section Options | Archaeological Sites within/adjacent to Roadway Section Alignment | Archaeological Sites in proximity to Roadway Section Alignment | Recommendations | Potential Effects |
|---|---|---|---|---|
| Middle Bridge 1 | 19-PL-345, 19-BN-821 | 19-BN-224, 19-BN-690, 19-BN-937 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect sites 19-PL-345, 19-BN-821; Potential Effect sites 19-BN-690, 19-BN-937 |
| Middle Bridge 2 | 19-BN-654 | 19-BN-656, 19-BN-653 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect site 19-BN-654; Potential Effect sites 19-BN-656, 19-BN-653 |
| Sandwich Road | 19-BN-654 | | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect site 19-BN-654 |
| Relocated Exit 1C 4 Leg Roundabout | | 19-BN-908, 19-BN-913, 19-BN-914, 19-BN-915, 19-BN-943 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Potential Effect sites 19-BN-908, 19-BN-914, 19-BN-915, |
| Route 3 to Route 25 | 19-BN-821, 19-BN-870, BOU.2 | BOU.3, 19-BN-685 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect sites 19-BN-821, 19-BN-870, BOU.2; Potential Effect Sites BOU.3, 19-BN-685 |
| Sagamore Twin | 19-BN-635, 19-BN-909, 19-BN-910, 19-BN-911, 19-BN-912, | 19-BN-634, 19-BN-901, 19-BN-902, 19-BN-903, 19-BN-987 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effects sites 19-BN-635, 19-BN-909, 19-BN-910, 19-BN-911, 19-BN-912; Potential Effect Sites 19-BN-634, 19-BN-901, 19-BN-902, 19-BN-903, 19-BN-987 |
| New Route 6 EB Travel Lane | 19-BN-908 | 19-BN-631, 19-BN-632, 19-BN-633, 19-BN-634, 19-BN-635, 19- | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of | Direct Effects sites 19-BN-634, 19-BN-687, 19-BN-902, 19-BN-909, 19-BN-910, |

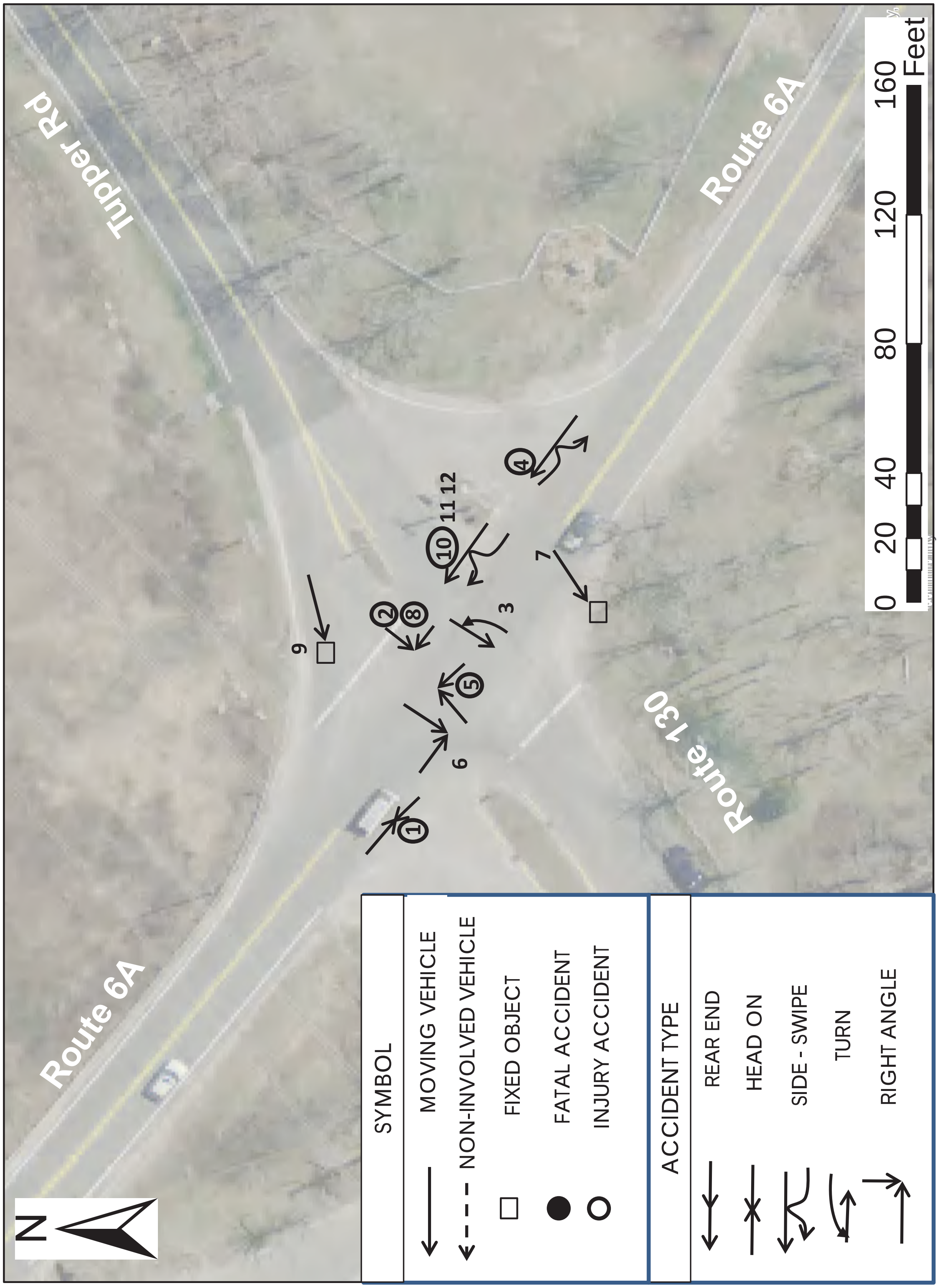
| | | | | |
|---|---|---|---|---|
| | | BN-901, 19-BN-902, 19-BN-903, 19-BN-907, 19-BN-909, 19-BN-910, 19-BN-911, 19-BN-912, 19-BN-914, and 19-BN-987 | sensitive areas | 19-BN-911, 19-BN-912, 19-BN-987; Potential Effect Sites 19-BN-631, 19-BN-632, 19-BN-633, 19-BN-901, 19-BN-903 |
| Scenic Highway | 19-BN-224, 19-BN-690, 19-BN-937 | 19-BN-224, 19-BN-690,19-BN-937, 19-BN-870, 19-BN-620 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect sites 19-BN-224, 19-BN-690, 19-BN-937; Potential Effects Sites 19-BN-870, 19-BN-620 |
| Bourne Bridge Replacement and Immediate Approaches | BOU.1, 19-BN-244 | BOU.4 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect Sites BOU.1, BOU.4, 19-BN-244; Potential Effect Site BOU.4 |
| Belmont circle and Scenic Highway to Route 25 Ramp | BOU.1, 19-BN-244 | BOU.4 | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | Direct Effect Sites BOU.1, BOU.4, 19-BN-244; Potential Effect Site BOU.4 |
| Bourne Rotary Alternative 2A | N/A | N/A | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | No Direct or Potential Effects on documented archaeological resources |
| Bourne Rotary Alternative 3A | N/A | N/A | Walkover survey and visual assessment to refine areas of sensitivity; Intensive (locational) archaeological survey of sensitive areas | No Direct or Potential Effects on documented archaeological resources |

# Appendix D:
# Vehicle Collision Diagrams

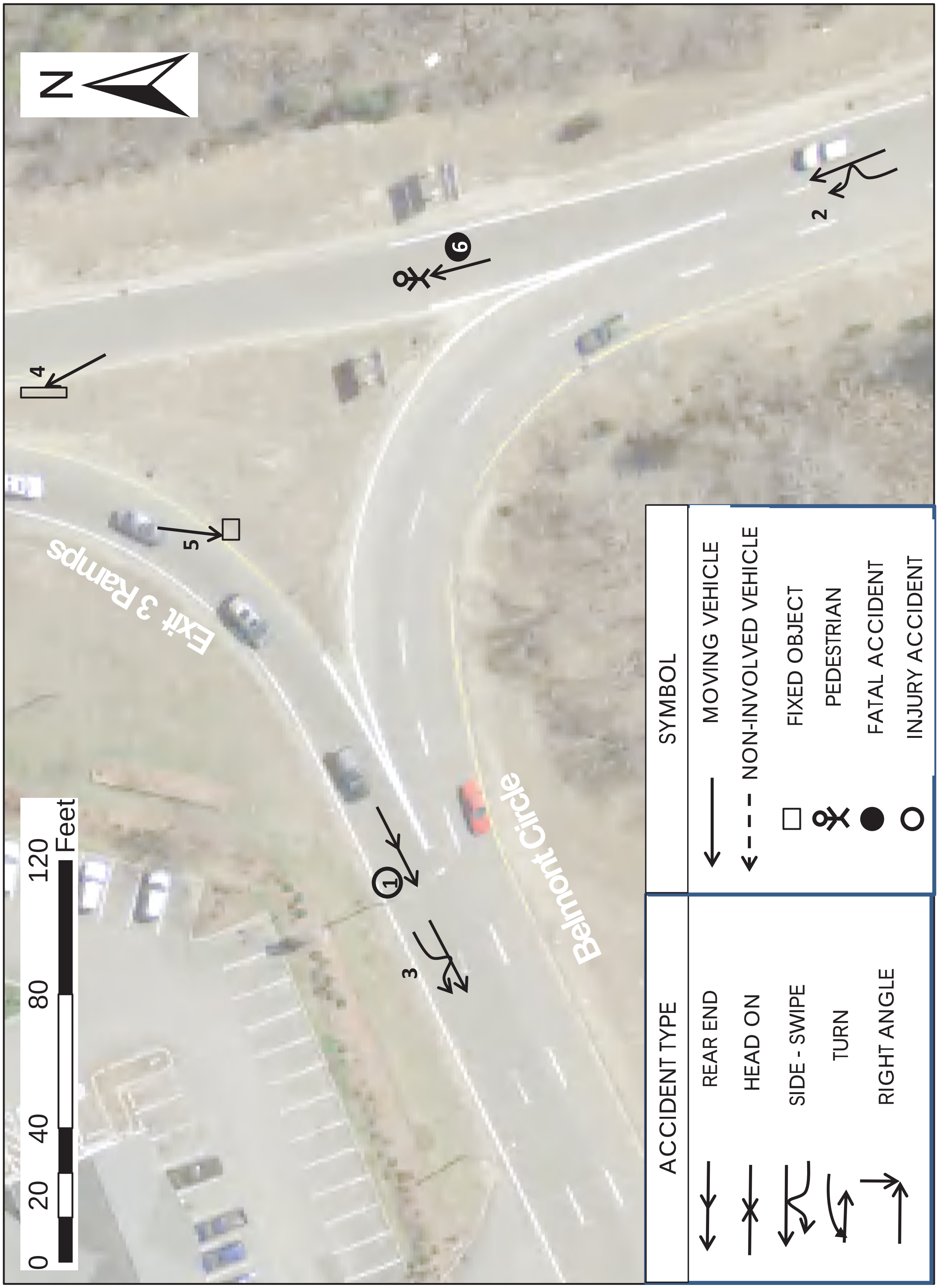
## Vehicle Collision Diagram: Sandwich Rd at Adams Street



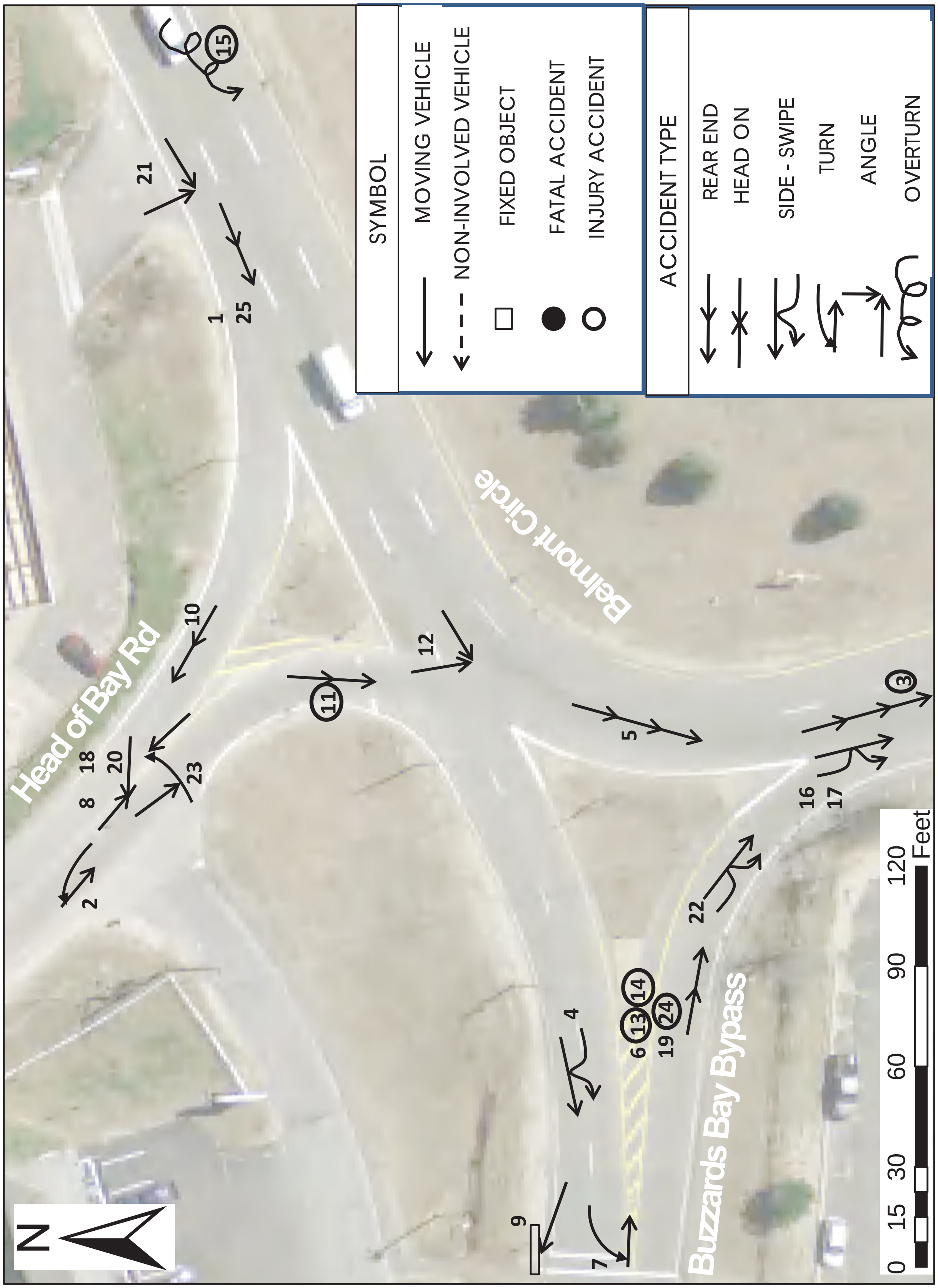
## Vehicle Collision Diagram: Route 6A at Tupper Road/Route 130



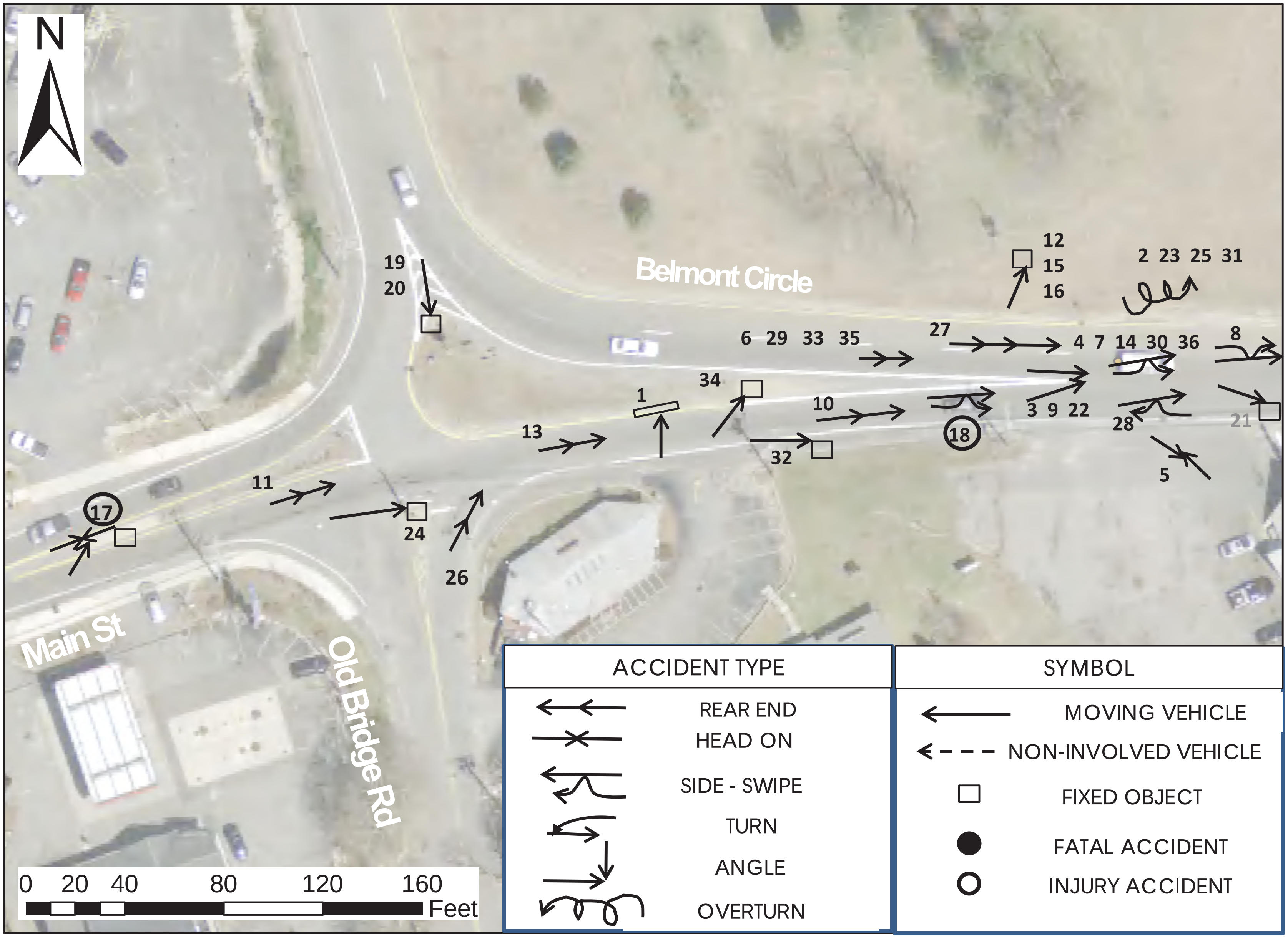
Vehicle Collision Diagram: Belmont Circle at Exit 3 Ramps



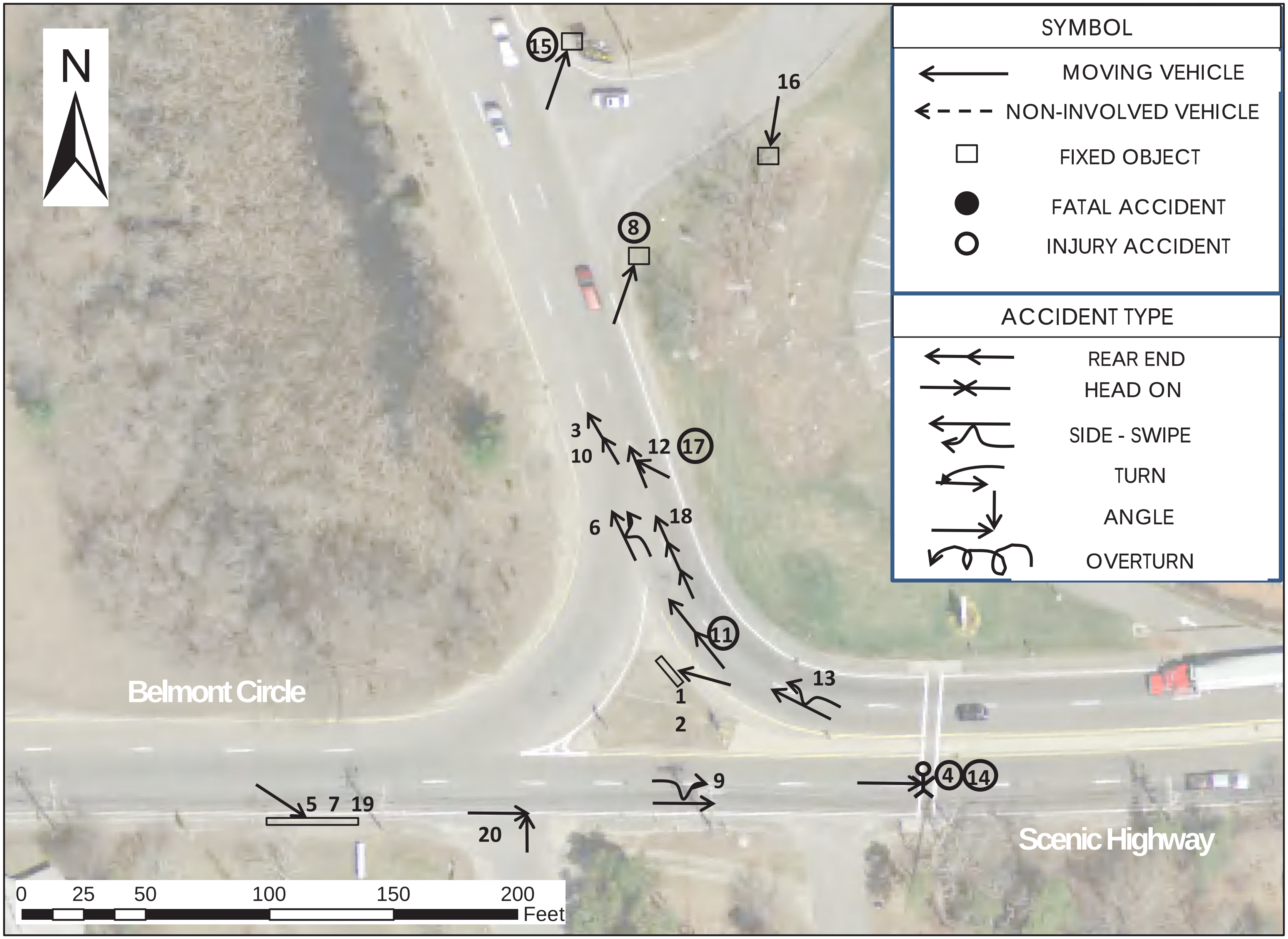
Vehicle Collision Diagram: Belmont Circle at Head of Bay Rd/Buzzards Bay Bypass



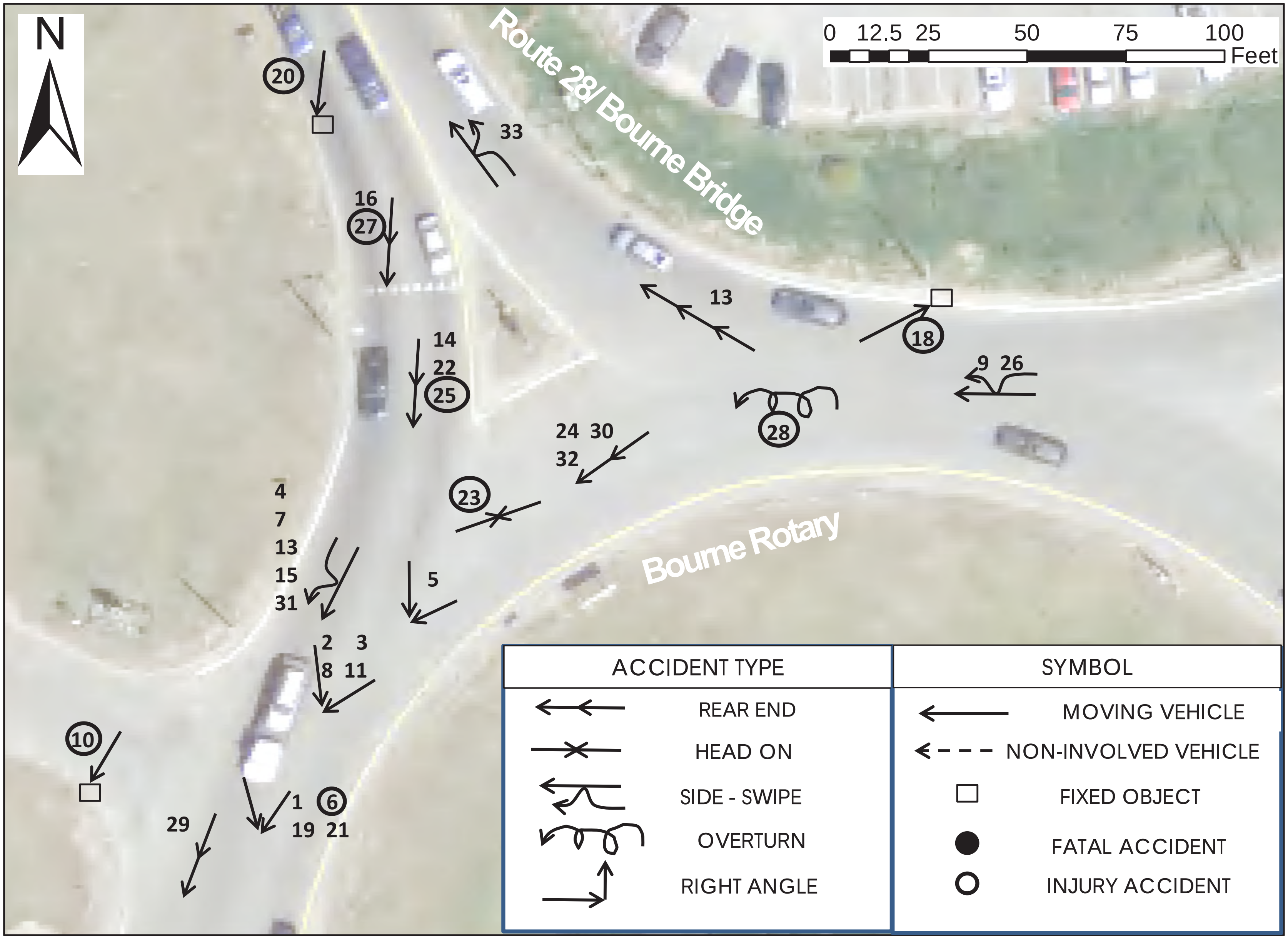
Vehicle Collision Diagram: Belmont Circle at Main Street/Old Bridge Road



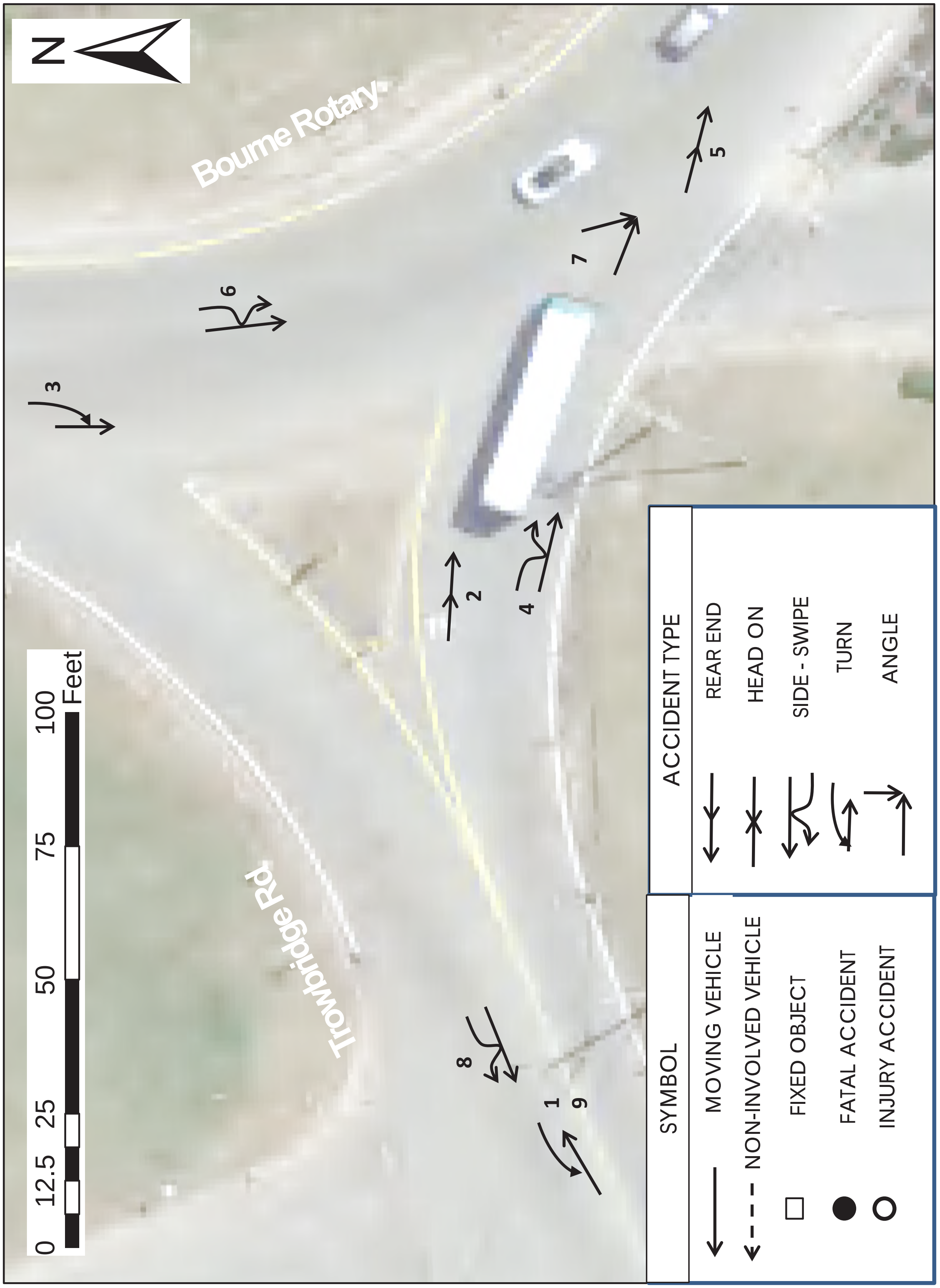
Vehicle Collision Diagram: Belmont Circle at **Scenic Highway**



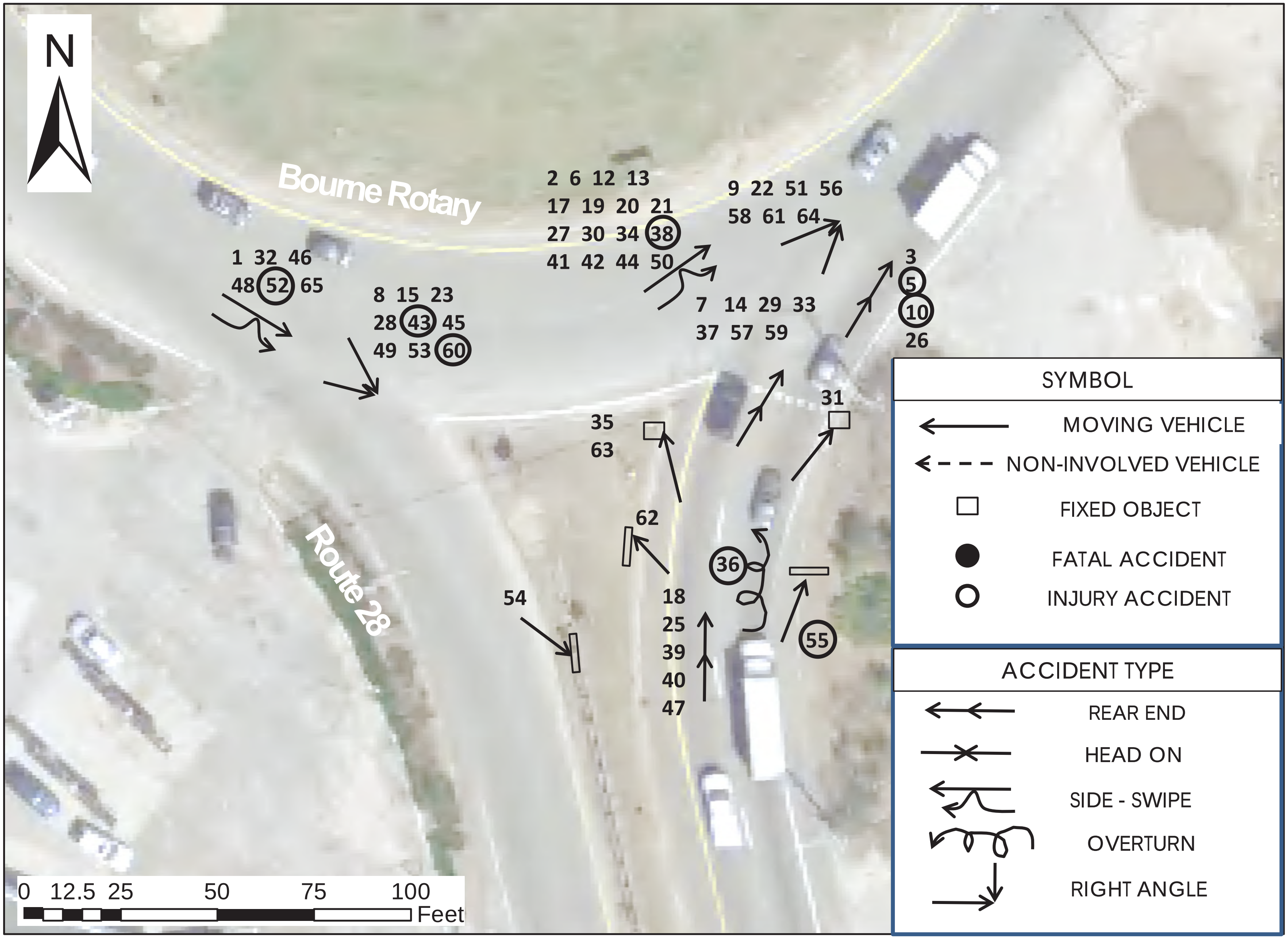
## Vehicle Collision Diagram: Bourne Rotary (North)



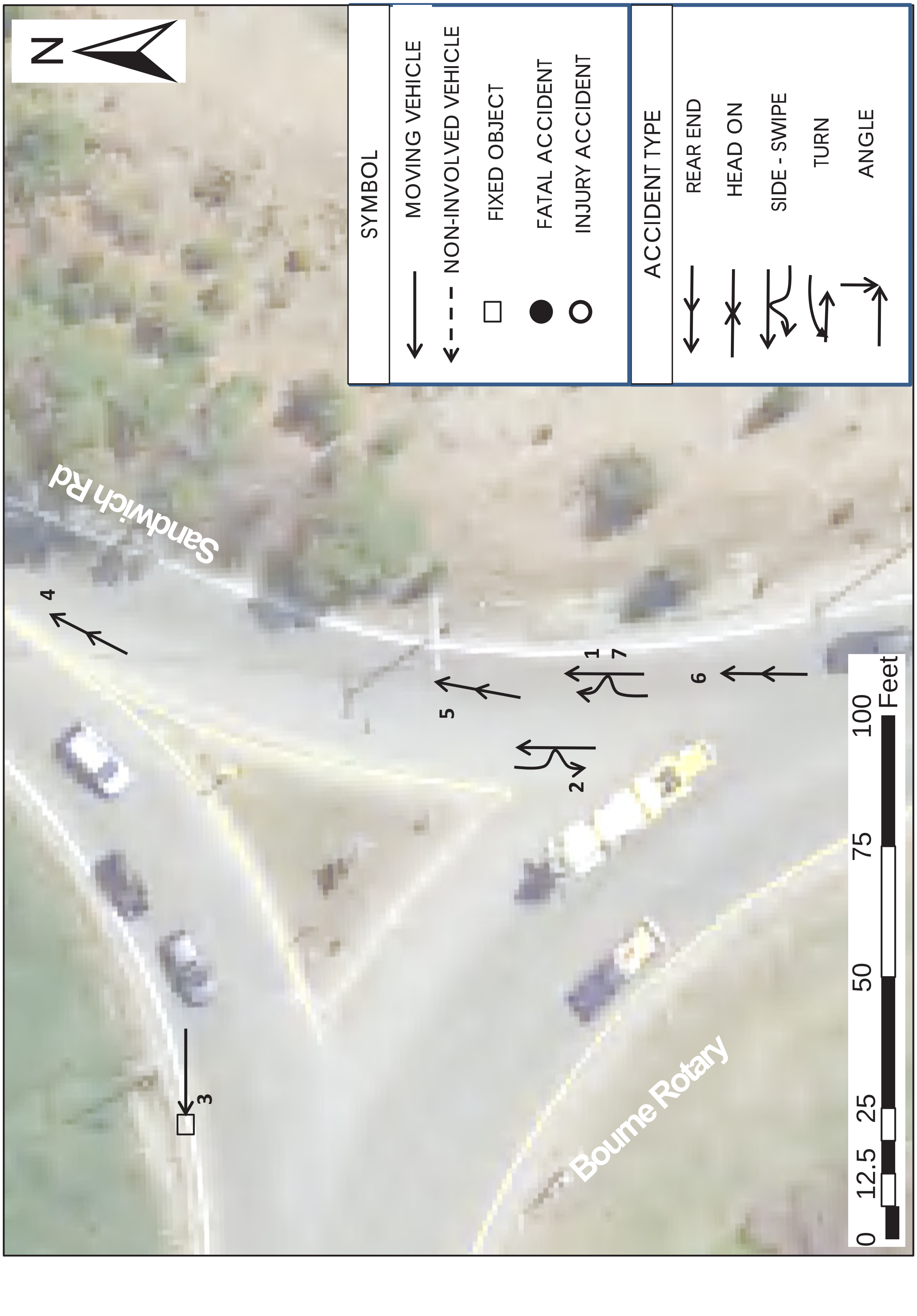
Vehicle Collision Diagram: Bourne Rotary (West)



Vehicle Collision Diagram: Bourne Rotary (South)



# Vehicle Collision Diagram: Bourne Rotary (East)



# Appendix E:
# Conceptual Cost Estimates

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**
Draft April 2018

# METHODOLOGY

The conceptual cost estimates for the Cape Cod Canal Transportation Study were developed for the purpose of comparing the order-of-magnitude costs of various transportation alternatives under consideration. These conceptual cost estimates were developed based on MassDOT's 2013 'Order of Magnitude Estimate of Construction Cost' per linear foot of roadway and square foot of bridge costs, for various improvements in the Cape Cod Canal area. This conceptual cost estimate does not include new canal bridge crossings which is being developed by the U.S. Army Corps of Engineers. However it does include the approach sections for new Sagamore and Bourne Bridges in the general vicinity of the existing bridges.

For developing the conceptual estimate, Stantec used the same MassDOT average square foot cost of roadway ($31.67/SF), bridge, and retaining wall sections, escalating these costs by 4.0% per year to account for inflation. In addition, a 25% - 40% contingency was added to these conceptual costs to account for unknown(but not unexpected) costs related to environmental mitigation, utility relocation, traffic management (police details), and additional structural elements. A lower contingency was used for less complex design alternatives (e.g., short-term intersection improvements) while a 40% contingency was used for larger, more complex mid- and long-term design alternatives. A 75% contingency was used for larger projects involving substantial utility conflicts/potential relations (e.g., Route 6 Exit 1C relocation and Scenic Highway to Route 25 ramp). Based on coordination with MassDOT, P.E. design and construction engineering are each assumed to cost 15% of the 2017 estimate.

Future financial planning would require a more detailed cost estimate based on a higher level of design.

**CONTINGENCY COST ADDED AT EACH IMPROVEMENT LOCATION**

| Contingency % added to preliminary cost | Used at Following Locations |
|---|---|
| **25%** | 1. Park and Ride Lot |
| | 2. Bourne Rotary Reconstruction |
| | 3. Belmont Circle Reconstruction |
| | 4. Route 6 Eastbound Add-A-Lane |
| | 5. Intersection Reconstruction (various locations) |
| **40%** | 1. Bourne Bridge Approaches |
| | 2. Sagamore Bridge Approach |
| **75%** | 1. Route 6 - Relocated Exit 1C |
| | 2. Scenic Highway to Route 25 Westbound Ramp |

**CAPE COD CANAL TRANSPORTATION STUDY**

**CONCEPTUAL ESTIMATES**

Oct-18

## SUMMARY

SHADED AREAS INDICATE RECOMMENDED ALTERNATIVES

| ALTERNATIVE | | 2017 | Cost 2020 | Cost 2030 | Cost 2040 |
|---|---|---|---|---|---|
| N/A | **PARK AND RIDE LOT** | $2,776,195 | $3,122,942 | $4,622,365 | $6,841,100 |
| N/A | **SAGAMORE BRIDGE APPROACH ROADWAYS** | $38,651,648 | $43,479,239 | $64,354,994 | $95,245,391 |
| N/A | **BOURNE BRIDGE APPROACH ROADWAYS** | $50,649,334 | $56,975,436 | $84,331,142 | $124,810,090 |
| 1 | RELOCATED EXIT 1C (ALT. 1 - SIGNALIZED INTERSECTION) | $27,127,514 | $30,515,740 | $45,167,310 | $66,847,619 |
| | WB ON RAMP | $10,917,191 | $12,280,748 | $18,177,122 | $26,902,141 |
| | WB OFF RAMP | $9,545,733 | $10,737,995 | $15,893,646 | $23,522,595 |
| | 2 SIGNALIZED INTERSECTIONS | $6,664,590 | $7,496,997 | $11,096,542 | $16,422,882 |
| 2 | **RELOCATED EXIT 1C (ALT. 2 - 4-LEG ROUNDABOUT)** | $30,487,890 | $34,295,827 | $50,762,336 | $75,128,258 |
| | WB ON RAMP | $10,746,002 | $12,088,177 | $17,892,093 | $26,480,297 |
| | WB OFF RAMP | $6,249,696 | $7,030,283 | $10,405,744 | $15,400,501 |
| | 4 LEG ROUNDABOUT | $13,492,192 | $15,177,367 | $22,464,500 | $33,247,460 |
| 3 | RELOCATED EXIT 1C (ALT. 3 - 5-LEG ROUNDABOUT) | $27,976,746 | $31,471,042 | $46,581,283 | $68,940,298 |
| | WB ON RAMP | $11,516,352 | $12,954,744 | $19,174,726 | $28,378,595 |
| | WB OFF RAMP | $10,144,895 | $11,411,992 | $16,891,250 | $24,999,049 |
| | 5 LEG ROUNDABOUT | $6,315,500 | $7,104,305 | $10,515,307 | $15,562,654 |
| 1 | **SCENIC HWY TO ROUTE 25 WB ON RAMP** | $6,561,688 | $7,381,243 | $10,925,210 | $16,169,311 |
| | ROUTE 25 WB ON RAMP | $6,561,688 | $7,381,243 | $10,925,210 | $16,169,311 |
| 1 | **BELMONT CIRCLE (ALT. 1 - 3-LEG ROUNDABOUT W/ SIGNAL)** | $13,581,421 | $15,277,740 | $22,613,066 | $33,467,337 |
| | BELMONT CIRCLE - ALT 1 | $13,581,421 | $15,277,740 | $22,613,066 | $33,467,337 |
| 1A | BELMONT CIRCLE (ALT 1A - W/ FLY-OVER RAMP) | $24,431,995 | $27,483,552 | $40,679,272 | $60,205,323 |
| | BELMONT CIRCLE - ALT 1A | $24,431,995 | $27,483,552 | $40,679,272 | $60,205,323 |

1 OF 2

| | | | | | |
|---|---|---|---|---|---|
| 2 | BELMONT CIRCLE (ALT 2 4-LEG ROUNDABOUT) | $12,823,489 | $14,425,142 | $21,351,108 | $26,348,089 |
| | BELMONT CIRCLE - ALT 2 | $12,823,489 | $14,425,142 | $21,351,108 | $26,348,089 |
| 1 | BOURNE ROTARY - ALT 1 | $7,823,859 | $8,801,059 | $13,026,726 | $19,279,554 |
| 1A | BOURNE ROTARY - ALT 1A | $15,930,888 | $17,920,655 | $26,524,928 | $39,256,893 |
| 1B | **BOURNE ROTARY - ALT. 1B MID-TERM** | $6,389,311 | $7,187,336 | $10,638,203 | $15,744,541 |
| 2 | **BOURNE ROTARY (Alt. 2 - 3 SIGNALIZED INTERSECTIONS)** | $10,692,350 | $12,027,825 | $17,802,763 | $26,348,089 |
| 3A | **BOURNE ROTARY INTERCHANGE (ALT 3A - LONG-TERM)** | $41,182,065 | $46,325,705 | $68,568,138 | $101,480,844 |
| | NOTE: EXCLUDES PORTIONS OF ALT 2 ALREADY BUILT | | | | |
| N/A | **ROUTE 6 ADD-A-LANE (MID-CAPE CONNECTOR TO EXIT 2)** | $28,972,919 | $32,591,637 | $48,239,910 | $71,395,067 |
| Loc 2 | **Intersection of Route 6A and Cranberry Highway** | $583,575 | $656,464 | | |
| Loc 3 | **Intersection of Route 130 and Coutuit Road** | $955,650 | $1,075,011 | | |
| Loc 4 | **Intersection of Sandwich Road at Bourne Rotary Connector** | $1,855,781 | $2,087,568 | | |

2 OF 2

**CAPE COD CANAL TRANSPORTATION STUDY**

**CONCEPTUAL ESTIMATES**

Oct-18

## ROADWAY SEGMENTS

**ASSUMPTIONS:**

- PRICE PER FOOT OF NEW ROADWAY CONSTRUCTION IS BASED ON LINEAR FOOT COST OF THE 2013 MASSDOT ESTIMATE.
- PRICE PER FOOT OF ROADWAY RESURFACING IS ASSUMED TO BE $5.00 PER SF. RESURFACING PLUS ONE CONCRETE SIDEWALK = $6.00 PER SF. RESURFACING PLUS TWO CONCRETE SIDEWALKS = $7.00 PER SF. NEW CURBING FOR SIDEWALKS OR MEDIAN BARRIERS AN ADDITIONAL $40 PER LINEAR FOOR

**ROADWAY RESURFACING (COST PER LINEAR FOOT):**

| | 2017 SF Cost | 2017 PRICES |
|---|---|---|
| 1 LANE RAMP (24 FEET WIDE) | $5.00 | $120.00 |
| 1 LANE ROADWAY W/ ONE SIDEWALK (28 FEET WIDE) | $6.00 | $208.00 |
| 2 LANE ROADWAY (34 FT WIDE) | $5.00 | $170.00 |
| 2 LANE RAMP (36 FEET WIDE) | $5.00 | $180.00 |
| 2 LANE ROADWAY W/ ONE SIDEWALK (40 FT WIDE) | $6.00 | $280.00 |
| 2 LANE ROUNDABOUT (43 FEET WIDE) | $5.00 | $215.00 |
| 3 LANE ROADWAY (44 FEET WIDE) | $5.00 | $220.00 |
| 2 LANE ROADWAY W/ TWO SIDEWALKS (46 FT WIDE) | $7.00 | $402.00 |
| 3 LANE ROADWAY W/ ONE SIDEWALK (52 FT WIDE) | $6.00 | $352.00 |
| 3 LANE ROADWAY W/ TWO SIDEWALKS (58 FT WIDE) | $7.00 | $486.00 |
| 4 LANE ROADWAY (62 FT WIDE) | $5.00 | $310.00 |
| 4 LANE ROADWAY W/ TWO SIDEWALKS (70 FT WIDE) | $7.00 | $570.00 |
| 5 LANE ROADWAY (76 FT WIDE) | $5.00 | $380.00 |
| 4 LANE ROADWAY W/ MED BARRIER & ONE SIDEWALK (72 FT WIDE) | $6.00 | $512.00 |
| 4 LANE ROADWAY W/ MED BARRIER (82 FEET WIDE) | $5.00 | $450.00 |
| 4 LANE ROADWAY W/ MED BARRIER & 1 SW (88 FEET WIDE) | $6.00 | $608.00 |

**2013 AVE. SF COST**

**MULTI. BY TOTAL**

1 OF 48

**CAPE COD CANAL TRANSPORTATION STUDY**

**CONCEPTUAL ESTIMATES**

Oct-18

**NEW ROADWAY RECONSTRUCTION (COST PER LINEAR FOOT):**

| SEGMENTS FROM 2014 ESTIMATE: | | |
|---|---|---|
| ROADWAY WIDENING (18 FEET WIDE) | 570.06 | $666.97 |
| 1 LANE RAMP (22 FEET WIDE) | 696.74 | $815.19 |
| ACCESS DRIVEWAY (24 FEET WIDE) | 760.08 | $889.29 |
| 1 LANE ROADWAY W/ ONE SIDEWALK (28 FEET WIDE) | 886.76 | $1,037.51 |
| ROADWAY WIDENING (30 FEET WIDE) | 950.1 | $1,111.62 |
| 2 LANE ROUNDABOUT (33 FEET WIDE) | 1045.11 | $1,222.78 |
| 2 LANE ROADWAY (34 FT WIDE) | 1076.78 | $1,259.83 |
| 2 LANE RAMP (36 FEET WIDE) | 1140.12 | $1,333.94 |
| 2 LANE ROADWAY W/ ONE SIDEWALK (40 FT WIDE) | 1266.8 | $1,482.16 |
| 2 LANE ROUNDABOUT (43 FEET WIDE) | 1361.81 | $1,593.32 |
| 3 LANE ROADWAY (44 FEET WIDE) | 1393.48 | $1,630.37 |
| 2 LANE ROADWAY W/ TWO SIDEWALKS (46 FT WIDE) | 1456.82 | $1,704.48 |
| 3 LANE ROADWAY (46 FT WIDE) | 1456.82 | $1,704.48 |
| 3 LANE ROADWAY W/ ONE SIDEWALK (52 FT WIDE) | 1646.84 | $1,926.80 |
| 3 LANE RAMP (58 FEET WIDE) | 1836.86 | $2,149.13 |
| 3 LANE ROADWAY W/ TWO SIDEWALKS (58 FT WIDE) | 1836.86 | $2,149.13 |
| 4 LANE ROADWAY (58 FT WIDE) | 1836.86 | $2,149.13 |
| PARKING LOT (60 FEET WIDE) | 1900.2 | $2,223.23 |
| 4 LANE ROADWAY W/ ONE SIDEWALK (64 FT WIDE) | 2026.88 | $2,371.45 |
| 4 LANE ROADWAY W/ TWO SIDEWALKS (70 FT WIDE) | 2216.9 | $2,593.77 |
| 4 LANE ROADWAY W/ MED BARRIER (82 FEET WIDE) | 2596.94 | $3,038.42 |
| 4 LANE ROADWAY W/ MED & 1 SW (88 FEET WIDE) | 2786.96 | $3,260.74 |

## BRIDGE SEGMENTS

**ASSUMPTIONS:**

- PRICE PER SQUARE FOOT OF NEW BRIDGE CONSTRUCTION IS BASED ON SQUARE FOOT COST OF THE 2013 MASSDOT ESTIMATE. PRICES HAVE BEEN ESCALATED TO 2017 PRICES USING 4.0% ESCALATION FOR 3 YEARS.

**NEW BRIDGES:**

**CAPE COD CANAL TRANSPORTATION STUDY**

**CONCEPTUAL ESTIMATES**

Oct-18

| | | |
|---|---|---|
| UNDER 2,000 SF | $550.00 | $643.50 |
| 2,000 SF - 5,000 SF | $450.00 | $526.50 |
| 5,000 SF - 10,000 SF | $400.00 | $468.00 |
| OVER 10,000 SF | $350.00 | $409.50 |
| | | |
| 1 LANE RAMP BRIDGE (25 FEET WIDE) | | 18,330.00 |
| 2 LANE BOAT SECTION | | 10,000.00 |
| 2 LANE RAMP BRIDGE (39 FEET WIDE) | | 30,820.00 |
| 2 LANE ROADWAY BRIDGE (47 FEET WIDE) | | 31,980.00 |
| 4 LANE ROADWAY BRIDGE (85 FEET WIDE) | | 60,060.00 |
| | | |
| DECK WIDENING | | $650.00 |
| | | |
| RETAINING WALLS (MSE) / Sq. Ft. | | $100 |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**
**Oct-18**
**Costs per Travel Demand Model Case**

| **Case 1** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Route 6 Exit 1C Relocation (Alternative 2) | 30 | 34 | 51 | 75 |
| | **Total** | **37** | **41** | **62** | **91** |

| **Case 1A** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Bourne Rotary (Mid-Term Option 1B) | 6 | 7 | 11 | 16 |
| | **Total** | **13** | **14** | **22** | **32** |

| **Case 1B** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Bourne Rotary Reconstruction (Alternative 2)* | 11 | 12 | 18 | 26 |
| | **Total** | **18** | **19** | **29** | **42** |

| **Case 2** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Route 6 Exit 1C Relocation (Alternative 2) | 30 | 34 | 51 | 75 |
| | Bourne Rotary Reconstruction (Alternative 2)* | 11 | 12 | 18 | 26 |
| | Belmont Circle Reconstruction (Alternative 1) | 14 | 15 | 23 | 33 |
| | **Total** | **62** | **68** | **103** | **150** |

| **Case 2B** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Route 6 Exit 1C Relocation (Alternative 2) | 30 | 34 | 51 | 75 |
| | Bourne Rotary Reconstruction (Alternative 2)* | 11 | 12 | 18 | 26 |
| | Belmont Circle Reconstruction w/ Route 25 Flyover to Scenic Hwy (Alternative 1A) | 24 | 27 | 41 | 60 |
| | **Total** | **72** | **80** | **121** | **177** |

| **Case 3** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Route 6 Exit 1C Relocation (Alternative 2) | 30 | 34 | 51 | 75 |
| | Bourne Rotary Reconstruction (Alternative 2)* | 11 | 12 | 18 | 26 |
| | Belmont Circle Reconstruction (Alternative 1) | 14 | 15 | 23 | 33 |
| | Route 6 EB Travel Lane | 29 | 33 | 48 | 71 |
| | Sagamore Bridge Approaches | 39 | 43 | 64 | 95 |
| | Bourne Bridge Approaches | 51 | 57 | 84 | 125 |
| | **Total** | **181** | **201** | **299** | **441** |

| **Case 3A** | | **2017** | **2020** | **2030** | **2040** |
|---|---|---|---|---|---|
| | Scenic Hwy to Route 25 Ramp | 7 | 7 | 11 | 16 |
| | Route 6 Exit 1C Relocation (Alternative 2) | 30 | 34 | 51 | 75 |
| | Bourne Rotary Interchange** | 52 | 58 | 87 | 127 |
| | Belmont Circle Reconstruction (Alternative 1) | 14 | 15 | 23 | 33 |
| | Route 6 EB Travel Lane | 29 | 33 | 48 | 71 |
| | Sagamore Bridge Approaches | 39 | 43 | 64 | 95 |
| | Bourne Bridge Approaches | 51 | 57 | 84 | 125 |

| | | | | |
|---|---|---|---|---|
| **Total** | **222** | **247** | **368** | **542** |

All costs in $ Millions
* includes cost of reconstruction of Intersection Location 4
** Includes cost of Bourne Rotary Reconstruction (Alternative 2).
Costs of new Canal Bridges (assumed to be included in Cases 3 and 3A) but not included in these costs.

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### PARK AND RIDE LOT (ROUTE 6 AT EXIT 2, SANDWICH)

| | | |
|---|---|---|
| NEW ROADWAY CONSTRUCTION: | | |
| PARKING LOT | | $1,222,778.70 |
| 550 | foot roadway length | |
| 60 | feet wide | |
| $2,223 | per foot of length | |
| ACCESS DRIVE | | $177,858.72 |
| 200 | foot roadway length | |
| 24 | feet wide | |
| $889 | per foot of length | |
| 0.5 Factor for Wall Embank., Drainage | | $700,318.71 |
| OTHER ITEMS: | | |
| KIOSKS, SHELTERS, ETC. | | $50,000.00 |
| TRAFFIC SIGNAL MODIFICATIONS | | $50,000.00 |
| SIGNAGE | | $20,000.00 |
| | Subtotal: | $2,220,956.13 |
| | Contingencies* (25%): | $555,239.03 |
| | **Total (2017):** | **$2,776,195.16** |
| | **Total (2020):** | **$3,122,941.94** |
| | **Total (2030):** | **$4,622,364.95** |
| | **Total (2040):** | **$6,841,100.12** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | |
| | P.E. Design (15%): | $416,429.27 |
| | Construction Engineering (15%): | $416,429.27 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**SAGAMORE BRIDGE APPROACH ROADWAYS**

**NEW APPROACHES TO AND FROM THE SAGAMORE BRIDGE APPROACHES**

| | | |
|---|---|---|
| **NEW ROADWAY CONSTRUCTION:** | | $14,673,600.00 |
| 1,500 | feet on both sides of bridge | |
| 2 | barrells EB & WB (59 feet wide & 73 feet wide) | |
| 3,000 | foot roadway length | |
| $4,891 | per LF ($2,186 per LF & $2,705 per LF) | |
| 0.2 Factor for Embank., Drainage | | $2,934,720.00 |

**STRUCTURES:**

| | | |
|---|---|---|
| RETAINING WALLS | | $10,000,000.00 |

ASSUME AVERAGE HEIGHT OF 20 FEET AND AVERAGE LENGTH 1,000 LF x 2 SIDES x 2 APPROACHES = 4,000 LF

| | |
|---|---|
| 4,000 | feet of retaining wall |
| 25 | feet high (average) |
| 100,000 | square feet of retaining wall face |
| $100 | per square foot |

| | |
|---|---|
| Subtotal: | $27,608,320.00 |
| Contingencies* (40%): | $11,043,328.00 |
| **Total (2017):** | **$38,651,648.00** |
| **Total (2020):** | **$43,479,238.84** |
| **Total (2030):** | **$64,354,993.92** |
| **Total (2040):** | **$95,245,391.00** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $5,797,747.20 |
| Construction Engineering (15%): | $5,797,747.20 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### BOURNE BRIDGE APPROACH ROADWAYS

**NEW APPROACHES TO AND FROM THE BOURNE BRIDGE APPROACHES**

| | | |
|---|---|---|
| **NEW ROADWAY CONSTRUCTION:** | | $16,630,080.00 |
| 1,700 | LF (west side 1,300 LF east side 400 LF) of bridge | |
| 2 | barrells EB & WB (59 feet wide & 73 feet wide) | |
| 3,400 | foot roadway length | |
| $4,891 | per LF ($2,186 per LF & $2,705 per LF) | |
| 0.2 Factor for Embank., Drainage | | $3,326,016.00 |
| **STRUCTURES:** | | |
| RETAINING WALLS | | $8,500,000.00 |
| ASSUME AVERAGE HEIGHT OF 20 FEET AND AVERAGE LENGTH 1,700 LF x 2 SIDES = 3,400 LF | | |
| 3,400 | feet of retaining wall | |
| 25 | feet high (average) | |
| 85,000 | square feet of retaining wall face | |
| $100 | per square foot | |
| BRIDGE - ROUTE 25 OVER SCENIC HIGHWAY | | $7,722,000.00 |
| ASSUME LENGTH OF BRIDGE IS 150 LF AND WIDTH OF BRIDGE IS 132 LF | | |
| 150 | feet long | |
| 132 | feet long | |
| 19800 | square feet of bridge | |
| $390 | per square foot | |
| | Subtotal: | $36,178,096.00 |
| | Contingencies* (40%): | $14,471,238.40 |
| | **Total (2017):** | **$50,649,334.40** |
| | **Total (2020):** | **$56,975,436.27** |
| | **Total (2030):** | **$84,331,141.78** |
| | **Total (2040):** | **$124,810,089.83** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $7,597,400.16 |
| Construction Engineering (15%): | $7,597,400.16 |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE BRIDGE APPROACH ROADWAYS**

*	- Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 1 (SIGNALIZED INTERSECTION)**

**SECTION 1 - WB ON RAMP**

NEW ROADWAY CONSTRUCTION:

| | | | |
|---|---|---|---|
| ROADWAY WIDENING AND TAPER | | | $800,364.24 |
| 1,200 | foot roadway length | | |
| 18 | feet wide | | |
| $667 | per foot of length | | |
| 1 LANE RAMP | | | $3,358,565.50 |
| 4,120 | foot roadway length | | |
| 22 | feet wide | | |
| $815 | per foot of length | | |
| 0.5 Factor for Wall Embank., Drainage | | | $2,079,464.87 |
| | | Subtotal: | $6,238,394.60 |
| | | Contingencies* (75%): | $4,678,795.95 |
| | | **Total (2017):** | **$10,917,190.56** |
| | | **Total (2020):** | **$12,280,747.66** |
| | | **Total (2030):** | **$18,177,122.28** |
| | | **Total (2040):** | **$26,902,140.97** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,637,578.58 |
| Construction Engineering (15%): | $1,637,578.58 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**RELOCATED EXIT 1C - OPTION 1 (SIGNALIZED INTERSECTION)**
**Page 2**

**SECTION 2 - WB OFF RAMP**

NEW ROADWAY CONSTRUCTION:

| | | |
|---|---|---|
| ROADWAY WIDENING AND TAPER | | $473,548.84 |
| 710 | foot roadway length | |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 1 (SIGNALIZED INTERSECTION)

| | | | |
|---|---|---|---|
| | 18 | feet wide | |
| | $667 | per foot of length | |
| 1 LANE RAMP | | | $3,162,920.90 |
| | 3,880 | foot roadway length | |
| | 22 | feet wide | |
| | $815 | per foot of length | |
| 0.5 Factor for Wall Embank., Drainage | | | $1,818,234.87 |
| | | Subtotal: | $5,454,704.62 |
| | | Contingencies* (75%): | $4,091,028.46 |
| | | **Total (2017):** | **$9,545,733.08** |
| | | **Total (2020):** | **$10,737,995.15** |
| | | **Total (2030):** | **$15,893,645.58** |
| | | **Total (2040):** | **$23,522,595.46** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,431,859.96 |
| Construction Engineering (15%): | $1,431,859.96 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

### RELOCATED EXIT 1C - ALTERNATIVE 1 (SIGNALIZED INTERSECTION)

**SECTION 3 - TWO SIGNALIZED INTERSECTIONS** **Page 3**

ROADWAY RESURFACING:

| | | | |
|---|---|---|---|
| 1 LANE RAMP | | | $24,000.00 |
| | 200 | foot roadway length | |
| | 22 | feet wide | |
| | $120 | per foot of length | |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 1 (SIGNALIZED INTERSECTION)

| | | |
|---|---|---|
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $381,900.00 |
| 950 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 3 LANE ROADWAY W/ ONE SIDEWALK | | $123,200.00 |
| 350 | foot roadway length | |
| 52 | feet wide | |
| $352 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $563,760.00 |
| 1,160 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| NEW ROADWAY CONSTRUCTION: | | |
| 1 LANE RAMP | | $228,252.02 |
| 280 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| 4 LANE ROADWAY | | $1,633,335.91 |
| 760 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| OTHER ITEMS: | | |
| TRAFFIC SIGNALS | | $600,000.00 |
| | Subtotal: | $3,554,447.94 |
| 0.5 Factor for Wall Embank., Drainage | | $1,777,223.97 |
| | Contingencies* (25%): | $1,332,917.98 |
| | **Total (2017):** | **$6,664,589.88** |
| | **Total (2020):** | **$7,496,997.16** |
| | **Total (2030):** | **$11,096,542.15** |
| | **Total (2040):** | **$16,422,882.38** |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 1 (SIGNALIZED INTERSECTION)**

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $999,688.48 |
| Construction Engineering (15%): | $999,688.48 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**Grand Total of Sections 1, 2 and 3**

| | |
|---|---|
| **Total (2017):** | **$27,127,513.52** |
| **Total (2020):** | **$30,515,739.96** |
| **Total (2030):** | **$45,167,310.01** |
| **Total (2040):** | **$66,847,618.82** |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)

**SECTION 1 - WB ON RAMP**

NEW ROADWAY CONSTRUCTION:

| | | | |
|---|---|---|---|
| ROADWAY WIDENING AND TAPER | | | $800,364.24 |
| 1,200 | foot roadway length | | |
| 18 | feet wide | | |
| $667 | per foot of length | | |
| 1 LANE RAMP | | | $3,293,350.63 |
| 4,040 | foot roadway length | | |
| 22 | feet wide | | |
| $815 | per foot of length | | |
| | | Subtotal: | $4,093,714.87 |
| 0.5 Factor for Wall Embank., Drainage | | | $2,046,857.44 |
| | | Contingencies* (75%): | $4,605,429.23 |
| | | **Total (2017):** | **$10,746,001.54** |
| | | **Total (2020):** | **$12,088,177.13** |
| | | **Total (2030):** | **$17,892,092.56** |
| | | **Total (2040):** | **$26,480,296.99** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,611,900.23 |
| Construction Engineering (15%): | $1,611,900.23 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

### RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)

**SECTION 2 - WB OFF RAMP** **Page 2**

NEW ROADWAY CONSTRUCTION:

| | | |
|---|---|---|
| ROADWAY WIDENING AND TAPER | | $473,548.84 |
| 710 | foot roadway length | |
| 18 | feet wide | |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)**

| | | | |
|---|---|---|---|
| | $667 | per foot of length | |
| 1 LANE RAMP | | | $3,097,706.04 |
| | 3,800 | foot roadway length | |
| | 22 | feet wide | |
| | $815 | per foot of length | |
| 0.5 Factor for Wall Embank., Drainage | | | $1,785,627.44 |
| | | Subtotal: | $3,571,254.88 |
| | | Contingencies* (75%): | $2,678,441.16 |
| | | **Total (2017):** | **$6,249,696.04** |
| | | **Total (2020):** | **$7,030,283.08** |
| | | **Total (2030):** | **$10,405,743.91** |
| | | **Total (2030):** | **$15,400,500.99** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $937,454.41 |
| Construction Engineering (15%): | $937,454.41 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)**

**Page 3**

**SECTION 3 - 4-LEG ROUNDABOUT**

ROADWAY RESURFACING:

| | | | |
|---|---|---|---|
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | | $192,960.00 |
| | 480 | foot roadway length | |
| | 46 | feet wide | |
| | $402 | per foot of length | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | | $114,000.00 |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)**

| | | |
|---|---|---|
| 200 | foot roadway length | |
| 70 | feet wide | |
| $570 | per foot of length | |
| NEW ROADWAY CONSTRUCTION: | | |
| 2 LANE ROUNDABOUT | | $654,186.60 |
| 535 | foot roadway length | |
| 33 | feet wide | |
| $1,223 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $1,874,927.34 |
| 1,100 | foot roadway length | |
| 46 | feet wide | |
| $1,704 | per foot of length | |
| 4 LANE ROADWAY | | $1,869,739.79 |
| 870 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $2,490,022.08 |
| 960 | foot roadway length | |
| 70 | feet wide | |
| $2,594 | per foot of length | |
| 0.5 Factor for Wall Embank., Drainage | | $3,597,917.91 |
| | Subtotal: | $10,793,753.73 |
| | Contingencies* (25%): | $2,698,438.43 |
| | **Total (2017):** | **$13,492,192.16** |
| | **Total (2020):** | **$15,177,366.96** |
| | **Total (2030):** | **$22,464,499.95** |
| | **Total (2040):** | **$33,247,459.92** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $2,023,828.82 |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 2 (4-LEG ROUNDABOUT)

| | |
|---|---|
| Construction Engineering (15%): | $2,023,828.82 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**Grand Total of Sections 1, 2 and 3**

| | |
|---|---|
| **Total (2017):** | **$30,487,889.74** |
| **Total (2020):** | **$34,295,827.17** |
| **Total (2030):** | **$50,762,336.42** |
| **Total (2040):** | **$75,128,257.90** |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)**

**SECTION 1 - WB ON RAMP**

NEW ROADWAY CONSTRUCTION:

| | | | |
|---|---|---|---|
| ROADWAY WIDENING AND TAPER | | | $800,364.24 |
| 1,200 | foot roadway length | | |
| 18 | feet wide | | |
| $667 | per foot of length | | |
| 1 LANE RAMP | | | $3,586,817.52 |
| 4,400 | foot roadway length | | |
| 22 | feet wide | | |
| $815 | per foot of length | | |
| 0.5 Factor for Wall Embank., Drainage | | | $2,193,590.88 |
| | | Subtotal: | $6,580,772.64 |
| | | Contingencies* (75%): | $4,935,579.48 |
| | | **Total (2017):** | **$11,516,352.12** |
| | | **Total (2020):** | **$12,954,744.50** |
| | | **Total (2030):** | **$19,174,726.28** |
| | | **Total (2040):** | **$28,378,594.89** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,727,452.82 |
| Construction Engineering (15%): | $1,727,452.82 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)**

**SECTION 2 - WB OFF RAMP** **Page 2**

NEW ROADWAY CONSTRUCTION:

ROADWAY WIDENING AND TAPER $473,548.84

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)

| | | |
|---|---|---|
| 710 | foot roadway length | |
| 18 | feet wide | |
| $667 | per foot of length | |
| 1 LANE RAMP | | $3,391,172.93 |
| 4,160 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| 0.5 Factor for Wall Embank., Drainage | | $1,932,360.89 |
| | Subtotal: | $5,797,082.66 |
| | Contingencies* (75%): | $4,347,811.99 |
| | **Total (2017):** | **$10,144,894.65** |
| | **Total (2032):** | **$11,411,991.99** |
| | **Total (2030):** | **$16,891,249.59** |
| | **Total (2040):** | **$24,999,049.39** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | | |
|---|---|---|
| | P.E. Design (15%): | $1,521,734.20 |
| | Construction Engineering (15%): | $1,521,734.20 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

### RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)

**SECTION 3 - 5-LEG ROUNDABOUT** **Page 3**

ROADWAY RESURFACING:

| | | |
|---|---|---|
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $333,660.00 |
| 830 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)

| | | |
|---|---|---|
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $302,100.00 |
| 530 | foot roadway length | |
| 70 | feet wide | |
| $570 | per foot of length | |
| | | |
| NEW ROADWAY CONSTRUCTION: | | |
| 1 LANE RAMP | | $317,922.46 |
| 390 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| | | |
| 2 LANE ROUNDABOUT | | $654,186.60 |
| 535 | foot roadway length | |
| 33 | feet wide | |
| $1,223 | per foot of length | |
| | | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $767,015.73 |
| 450 | foot roadway length | |
| 46 | feet wide | |
| $1,704 | per foot of length | |
| | | |
| 4 LANE ROADWAY | | $1,225,001.93 |
| 570 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| | | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $1,452,512.88 |
| 560 | foot roadway length | |
| 70 | feet wide | |
| $2,594 | per foot of length | |
| | | |
| 0.5 Factor for Wall Embank., Drainage | | $893,086.44 |
| | Subtotal: | $5,052,399.61 |
| | Contingencies* (25%): | $1,263,099.90 |
| | **Total (2017):** | **$6,315,499.51** |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**RELOCATED EXIT 1C - OPTION 3 (5-LEG ROUNDABOUT)**

| | |
|---|---|
| **Total (2020):** | **$7,104,305.40** |
| **Total (2030):** | **$10,515,306.69** |
| **Total (2040):** | **$15,562,653.90** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $947,324.93 |
| Construction Engineering (15%): | $947,324.93 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**Grand Total of Sections 1, 2 and 3**

| | |
|---|---|
| **Total (2017):** | **$27,976,746.28** |
| **Total (2020):** | **$31,471,041.89** |
| **Total (2030):** | **$46,581,282.56** |
| **Total (2040):** | **$68,940,298.18** |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**SCENIC HIGHWAY TO ROUTE 25 WB ON-RAMP**

| | | |
|---|---|---|
| **ROUTE 25 WB ON RAMP** | | |
| ROADWAY RESURFACING: | | |
| 3 LANE ROADWAY (NIGHTINGALE ROAD) | | $39,600.00 |
| 180 | foot roadway length | |
| 44 | feet wide | |
| $220 | per foot of length | |
| NEW ROADWAY CONSTRUCTION: | | |
| ROADWAY WIDENING AND TAPER | | $400,182.12 |
| 600 | foot roadway length | |
| 18 | feet wide | |
| $667 | per foot of length | |
| 1 LANE RAMP | | $611,389.35 |
| 750 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| 1 Lane Widening Route 28 WB | | $815,185.80 |
| 1,000 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| STRUCTURAL: | | |
| RETAINING WALL | | $500,000.00 |
| 200 | foot retaining wall | |
| 25 | foot high | |
| 5,000 | square foot of wall face | |
| $100 | per square foot of wall face | |
| TRAFFIC SIGNAL MODIFICATIONS | | $300,000.00 |
| 0.5 Factor for Embank., Drainage | | $1,083,178.64 |
| | Subtotal: | $3,749,535.91 |
| | Contingencies* (75%): | $2,812,151.93 |
| | **Total (2017):** | **$6,561,687.83** |
| | **Total (2020):** | **$7,381,242.64** |
| | **Total (2030):** | **$10,925,210.24** |
| | **Total (2040):** | **$16,169,311.16** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | |
| | P.E. Design (15%): | $984,253.18 |
| | Construction Engineering (15%): | $984,253.18 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 1 - 3 LEG ROUNDABOUT WITH SIGNALIZED INTERSECTION**

| | | |
|---|---|---|
| **BELMONT CIRCLE** | | |
| ROADWAY RESURFACING: | | |
| 1 LANE RAMP | | $60,000.00 |
| 500 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 2 LANE RAMP | | $61,200.00 |
| 340 | foot roadway length | |
| 36 | feet wide | |
| $180 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $313,560.00 |
| 780 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $388,800.00 |
| 800 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 4 LANE ROADWAY W/ MED BARRIER (82 FEET WIDE) | | $517,500.00 |
| 1,150 | foot roadway length | |
| 82 | feet wide | |
| $450 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $670,530.00 |
| NEW ROADWAY CONSTRUCTION: | | |
| 1 LANE RAMP | | $163,037.16 |
| 200 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| 2 LANE ROUNDABOUT | | $654,186.60 |
| 535 | foot roadway length | |
| 33 | feet wide | |
| $1,223 | per foot of length | |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

**BELMONT CIRCLE - ALTERNATIVE 1 - 3 LEG ROUNDABOUT WITH SIGNALIZED INTERSECTION**

**BELMONT CIRCLE - ALTERNATIVE 1 - 3 LEG ROUNDABOUT WITH SIGNALIZED INTERSECTION**

| | | | |
|---|---|---|---|
| | | | **Page 2** |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | | $1,585,165.84 |
| 930 | foot roadway length | | |
| 46 | feet wide | | |
| $1,704 | per foot of length | | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | | $429,825.24 |
| 200 | foot roadway length | | |
| 58 | feet wide | | |
| $2,149 | per foot of length | | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | | $855,945.09 |
| 330 | foot roadway length | | |
| 70 | feet wide | | |
| $2,594 | per foot of length | | |
| 4 LANE ROADWAY W/ MED BARRIER (82 FEET WIDE) | | | $1,914,204.47 |
| 630 | foot roadway length | | |
| 82 | feet wide | | |
| $3,038 | per foot of length | | |
| OTHER ITEMS: | | | |
| TRAFFIC SIGNAL | | | $300,000.00 |
| 0.5 Factor for Wall Embank., Drainage | | | $2,951,182.21 |
| | | Subtotal: | $10,865,136.62 |
| | | Contingencies* (25%): | $2,716,284.15 |
| | | **Total (2017):** | **$13,581,420.77** |
| | | **Total (2020):** | **$15,277,740.22** |
| | | **Total (2030):** | **$22,613,065.58** |
| | | **Total (2040):** | **$33,467,337.06** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 1 - 3 LEG ROUNDABOUT WITH SIGNALIZED INTERSECTION**

| | |
|---|---|
| P.E. Design (15%): | $2,037,213.12 |
| Construction Engineering (15%): | $2,037,213.12 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 1A - 3 LEG ROUNDABOUT WITH ROUTE 25 FLYOVER**

**BELMONT CIRCLE**

ROADWAY RESURFACING:

| | | |
|---|---|---|
| 1 LANE RAMP | | $96,000.00 |
| 800 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 1 LANE ROADWAY W/ ONE SIDEWALK | | $104,000.00 |
| 500 | foot roadway length | |
| 28 | feet wide | |
| $208 | per foot of length | |
| 2 LANE RAMP | | $306,000.00 |
| 1,700 | foot roadway length | |
| 36 | feet wide | |
| $180 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $221,100.00 |
| 550 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $413,100.00 |
| 850 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 4 LANE ROADWAY W/ MED BARRIER & ONE SIDEWALK | | $128,000.00 |
| 250 | foot roadway length | |
| 72 | feet wide | |
| $512 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $634,100.00 |



NEW ROADWAY CONSTRUCTION:

| | |
|---|---|
| 1 LANE ROADWAY W/ ONE SIDEWALK | $363,128.22 |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 1A - 3 LEG ROUNDABOUT WITH ROUTE 25 FLYOVER**

| | | |
|---|---|---|
| 350 | foot roadway length | |
| 28 | feet wide | |
| $1,038 | per foot of length | |
| 2 LANE ROUNDABOUT | | $654,186.60 |
| 535 | foot roadway length | |
| 33 | feet wide | |
| $1,223 | per foot of length | |
| 2 LANE ROADWAY | | $314,958.15 |
| 250 | foot roadway length | |
| 34 | feet wide | |
| $1,260 | per foot of length | |
| 2 LANE RAMP | | $400,182.12 |
| 300 | foot roadway length | |
| 36 | feet wide | |
| $1,334 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $1,107,911.61 |
| 650 | foot roadway length | |
| 46 | feet wide | |
| $1,704 | per foot of length | |
| 3 LANE ROADWAY W/ ONE SIDEWALK | | $732,185.06 |
| 380 | foot roadway length | |
| 52 | feet wide | |
| $1,927 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $429,825.24 |
| 200 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |



| | | |
|---|---|---|
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $907,820.55 |
| 350 | foot roadway length | |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 1A - 3 LEG ROUNDABOUT WITH ROUTE 25 FLYOVER**

| | | | |
|---|---|---|---|
| 70 | feet wide | | |
| $2,594 | per foot of length | | |
| STRUCTURAL: | | | |
| 1 LANE RAMP BRIDGE | | | $9,828,000.00 |
| 800 | foot roadway length | | |
| 30 | feet wide | | |
| 24,000 | square feet | | |
| $410 | per square foot of length | | |
| OTHER ITEMS: | | | |
| TRAFFIC SIGNAL | | | $300,000.00 |
| 0.5 Factor for Embank., Drainage | | | $2,605,098.78 |
| | | Subtotal: | $19,545,596.34 |
| | | Contingencies* (25%): | $4,886,399.08 |
| | | **Total (2017):** | **$24,431,995.42** |
| | | **Total (2020):** | **$27,483,551.65** |
| | | **Total (2030):** | **$40,679,272.38** |
| | | **Total (2040):** | **$60,205,323.12** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | | |
| | | P.E. Design (15%): | $3,664,799.31 |
| | | Construction Engineering (15%): | $3,664,799.31 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 2 - 4 LEG ROUNDABOUT**

**BELMONT CIRCLE**

ROADWAY RESURFACING:

| | | |
|---|---|---|
| 1 LANE RAMP | | $126,000.00 |
| 1,050 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 1 LANE ROADWAY W/ ONE SIDEWALK | | $135,200.00 |
| 650 | foot roadway length | |
| 28 | feet wide | |
| $208 | per foot of length | |
| 2 LANE RAMP | | $36,000.00 |
| 200 | foot roadway length | |
| 36 | feet wide | |
| $180 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $486,420.00 |
| 1,210 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $97,200.00 |
| 200 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $142,500.00 |
| 250 | foot roadway length | |
| 70 | feet wide | |
| $570 | per foot of length | |
| 5 LANE ROADWAY | | $152,000.00 |
| 400 | foot roadway length | |
| 70 | feet wide | |
| $380 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $587,660.00 |

# CAPE COD CANAL TRANSPORTATION STUDY
# CONCEPTUAL ESTIMATES

## BELMONT CIRCLE - ALTERNATIVE 2 - 4 LEG ROUNDABOUT

BELMONT CIRCLE - ALTERNATIVE 2 - 4 LEG ROUNDABOUT



| | | |
|---|---|---|
| NEW ROADWAY CONSTRUCTION: | | |
| 1 LANE ROADWAY W/ ONE SIDEWALK | | $415,003.68 |
| 400 | foot roadway length | |
| 28 | feet wide | |
| $1,038 | per foot of length | |
| 2 LANE ROUNDABOUT | | $654,186.60 |
| 535 | foot roadway length | |
| 33 | feet wide | |
| $1,223 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $1,960,151.31 |
| 1,150 | foot roadway length | |
| 46 | feet wide | |
| $1,704 | per foot of length | |
| 3 LANE ROADWAY W/ ONE SIDEWALK | | $867,061.26 |
| 450 | foot roadway length | |
| 52 | feet wide | |
| $1,927 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $859,650.48 |
| 400 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $907,820.55 |
| 350 | foot roadway length | |
| 70 | feet wide | |
| $2,594 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $2,831,936.94 |
| | Subtotal: | $10,258,790.83 |

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BELMONT CIRCLE - ALTERNATIVE 2 - 4 LEG ROUNDABOUT**

| | |
|---|---|
| Contingencies* (25%): | $2,564,697.71 |
| **Total (2017):** | **$12,823,488.53** |
| **Total (2020):** | **$14,425,142.25** |
| **Total (2030):** | **$21,351,108.41** |
| **Total (2040):** | **$31,599,640.44** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,923,523.28 |
| Construction Engineering (15%): | $1,923,523.28 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

`

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 1 - ROUTE 28 NB RAMP AND ROTARY RECONSTRUCTION**

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

ROADWAY RESURFACING:

| | | |
|---|---|---|
| 1 LANE RAMP | | $36,000.00 |
| 300 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 2 LANE ROADWAY W/ ONE SIDEWALKS | | $425,600.00 |
| 1,520 | foot roadway length | |
| 46 | feet wide | |
| $280 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $723,600.00 |
| 1,800 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 2 LANE ROUNDABOUT | | $258,000.00 |
| 1,200 | foot roadway length | |
| 43 | feet wide | |
| $215 | per foot of length | |
| 3 LANE ROADWAY W/ ONE SIDEWALKS | | $281,600.00 |
| 800 | foot roadway length | |
| 58 | feet wide | |
| $352 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $170,100.00 |
| 350 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 4 LANE ROADWAY | | $108,500.00 |
| 350 | foot roadway length | |
| 70 | feet wide | |
| $310 | per foot of length | |

**BOURNE ROTARY - ALTERNATIVE 1 - ROUTE 28 NB RAMP**

`

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

**BOURNE ROTARY - ALTERNATIVE 1 - ROUTE 28 NB RAMP AND ROTARY RECONSTRUCTION**

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT



| | | | |
|---|---|---|---|
| 4 LANE ROADWAY W/ MED & 1 SW | | | $364,800.00 |
| | 600 | foot roadway length | |
| | 88 | feet wide | |
| | $608 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | | $1,184,100.00 |
| NEW ROADWAY CONSTRUCTION: | | | |
| 1 LANE RAMP | | | $652,148.64 |
| | 800 | foot roadway length | |
| | 22 | feet wide | |
| | $815 | per foot of length | |
| 2 LANE ROADWAY | | | $855,945.09 |
| | 700 | foot roadway length | |
| | 24 | feet wide | |
| | $1,223 | per foot of length | |
| 2 LANE ROADWAY W/ ONE SIDEWALK | | | $296,431.20 |
| | 200 | foot roadway length | |
| | 24 | feet wide | |
| | $1,482 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | | $902,262.47 |
| | | Subtotal: | $6,259,087.40 |
| | | Contingencies* (25%): | $1,564,771.85 |
| | | **Total (2017):** | **$7,823,859.24** |
| | | **Total (2020):** | **$8,801,059.26** |
| | | **Total (2030):** | **$13,026,725.64** |
| | | **Total (2040):** | **$19,279,553.95** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

`

# CAPE COD CANAL TRANSPORTATION STUDY
# CONCEPTUAL ESTIMATES

## BOURNE ROTARY - ALTERNATIVE 1 - ROUTE 28 NB RAMP AND ROTARY RECONSTRUCTION

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

| | |
|---|---|
| P.E. Design (15%): | $1,173,578.89 |
| Construction Engineering (15%): | $1,173,578.89 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### BOURNE ROTARY - ALTERNATIVE 1A - ROUTE 28 NB AND SB RAMP

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

| | | |
|---|---|---|
| ROADWAY RESURFACING: | | |
| 1 LANE RAMP | | $24,000.00 |
| 200 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 1 LANE ROADWAY W/ ONE SIDEWALKS | | $208,000.00 |
| 1,000 | foot roadway length | |
| 46 | feet wide | |
| $208 | per foot of length | |
| 2 LANE ROADWAY W/ ONE SIDEWALKS | | $691,600.00 |
| 2,470 | foot roadway length | |
| 46 | feet wide | |
| $280 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $241,200.00 |
| 600 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 2 LANE ROUNDABOUT | | $258,000.00 |
| 1,200 | foot roadway length | |
| 43 | feet wide | |
| $215 | per foot of length | |
| 3 LANE ROADWAY W/ ONE SIDEWALKS | | $246,400.00 |
| 700 | foot roadway length | |
| 58 | feet wide | |
| $352 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $437,400.00 |
| 900 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |

BOURNE ROTARY - ALTERNATIVE 1A - ROUTE 28 NB AND SB RAMP

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 1A - ROUTE 28 NB AND SB RAMP**

**ASSUMPTIONS:**
THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

**Page 2**

| | | | |
|---|---|---|---|
| 4 LANE ROADWAY | | | $108,500.00 |
| | 350 | foot roadway length | |
| | 70 | feet wide | |
| | $310 | per foot of length | |
| 4 LANE ROADWAY W/ MED & 1 SW | | | $364,800.00 |
| | 600 | foot roadway length | |
| | 88 | feet wide | |
| | $608 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | | $1,289,950.00 |
| NEW ROADWAY CONSTRUCTION: | | | |
| 1 LANE RAMP | | | $1,874,927.34 |
| | 2,300 | foot roadway length | |
| | 22 | feet wide | |
| | $815 | per foot of length | |
| 1 LANE ROADWAY w/ ONE SIDEWALK | | | $933,758.28 |
| | 1,400 | foot roadway length | |
| | 24 | feet wide | |
| | $667 | per foot of length | |
| 2 LANE ROADWAY | | | $1,345,056.57 |
| | 1,100 | foot roadway length | |
| | 24 | feet wide | |
| | $1,223 | per foot of length | |
| 2 LANE ROADWAY W/ ONE SIDEWALK | | | $296,431.20 |
| | 200 | foot roadway length | |
| | 24 | feet wide | |
| | $1,482 | per foot of length | |
| 0.5 Factor for | | | $2,225,086.70 |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### BOURNE ROTARY - ALTERNATIVE 1A - ROUTE 28 NB AND SB RAMP

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

Embank., Drainage

BRIDGE CONSTRUCTION

| | | |
|---|---|---|
| 1 LANE RAMP BRIDGE | | $2,199,600.00 |
| 120 | foot roadway length | |
| 26 | feet wide | |
| $18,330 | per foot of length | |

| | |
|---|---|
| Subtotal: | $12,744,710.09 |
| Contingencies* (25%): | $3,186,177.52 |
| **Total (2017):** | **$15,930,887.61** |
| **Total (2020):** | **$17,920,655.47** |
| **Total (2030):** | **$26,524,927.86** |
| **Total (2040):** | **$39,256,893.24** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $2,389,633.14 |
| Construction Engineering (15%): | $2,389,633.14 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 1B - ROUTE 28 NB RAMP AND SANDWICH ROAD AT BOURNE ROTARY CONNECTOR RECONSTRUCTION**

**ASSUMPTIONS:**

THIS ESTIMATE INCLUDES INTERSECTION LOCATION 4 AND RELOCATION OF TECH HIGH SCHOOL DRIVEWAY

**BOURNE ROTARY - ALTERNATIVE 1 - ROUTE 28 NB RAMP**

| | | |
|---|---|---|
| 1 LANE RAMP | | $652,148.64 |
| 800 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |

**Location 4 - Intersection of Sandwich Road and Bourne Rotary Connector**

| | | |
|---|---|---|
| Old Sandwich Road | | $816,667.96 |
| | 3-Lane, 2 sidewalks | |
| 380 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| Bourne Rotary Connector | | $1,665,572.81 |
| | 3-Lane, 2 sidewalks | |
| 775 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| Sandwich Road | | $1,010,089.31 |
| | 3-Lane, 2 sidewalks | |
| 470 | foot roadway length | |
| 58 | feet wide | |
| $2,149 | per foot of length | |
| Traffic Control Signal | | $300,000.00 |

**Technical High School Driveway Relocation**

| | | |
|---|---|---|
| ACCESS DRIVE | | $666,970.20 |
| 750 | foot roadway length | |
| 24 | feet wide | |
| $889 | per foot of length | |

| | | |
|---|---|---|
| 0.5 Factor for Embank., Drainage | | $2,555,724.46 |
| | Subtotal: | $5,111,448.92 |
| | Contingencies* (25%): | $1,277,862.23 |
| | **Total (2017):** | **$6,389,311.14** |
| | **Total (2020):** | **$7,187,336.11** |
| | **Total (2030):** | **$10,638,203.05** |
| | **Total (2040):** | **$15,744,540.52** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | | |
|---|---|---|
| | P.E. Design (15%): | $958,396.67 |
| | Construction Engineering (15%): | $958,396.67 |

- Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 2 - 3 SIGNALIZED INTERSECTIONS**

**ASSUMPTIONS:**
THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

ROADWAY RESURFACING:

| | | |
|---|---|---|
| 1 LANE RAMP | | $18,000.00 |
| 150 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 2 LANE ROADWAY W/ TWO SIDEWALKS | | $269,340.00 |
| 670 | foot roadway length | |
| 46 | feet wide | |
| $402 | per foot of length | |
| 2 LANE ROUNDABOUT | | $234,350.00 |
| 1,090 | foot roadway length | |
| 43 | feet wide | |
| $215 | per foot of length | |
| 3 LANE ROADWAY W/ TWO SIDEWALKS | | $996,300.00 |
| 2,050 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 4 LANE ROADWAY W/ TWO SIDEWALKS | | $1,778,400.00 |
| 3,120 | foot roadway length | |
| 70 | feet wide | |
| $570 | per foot of length | |
| 4 LANE ROADWAY W/ MED & 1 SW | | $364,800.00 |
| 600 | foot roadway length | |
| 88 | feet wide | |
| $608 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $1,830,595.00 |

**BOURNE ROTARY - ALTERNATIVE 2 - 3 SIGNALIZED INTERSECTIONS**

**Page 2**

NEW ROADWAY CONSTRUCTION:

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 2 - 3 SIGNALIZED INTERSECTIONS**

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES INTERSECTION LOCATION 4 WAS BUILT AS A SHORT-TERM IMPROVEMENT

| | | | |
|---|---|---|---|
| 1 LANE RAMP | | | $774,426.51 |
| | 950 | foot roadway length | |
| | 22 | feet wide | |
| | $815 | per foot of length | |
| ACCESS DRIVE | | | $666,970.20 |
| | 750 | foot roadway length | |
| | 24 | feet wide | |
| | $889 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | | $720,698.36 |
| OTHER ITEMS: | | | |
| TRAFFIC SIGNALS (3 LOCATIONS) | | | $900,000.00 |
| | | Subtotal: | $8,553,880.07 |
| | | Contingencies* (25%): | $2,138,470.02 |
| | | **Total (2017):** | **$10,692,350.08** |
| | | **Total (2020):** | **$12,027,824.61** |
| | | **Total (2030):** | **$17,802,762.89** |
| | | **Total (2040):** | **$26,348,089.07** |

**FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION**

| | |
|---|---|
| P.E. Design (15%): | $1,603,852.51 |
| Construction Engineering (15%): | $1,603,852.51 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 3A - INTERCHANGE**

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES BOURNE ROTARY ALTERNATE 2 WAS BUILT AS A MID-TERM IMPROVEMENT

| | | |
|---|---|---|
| ROADWAY RESURFACING: | | |
| 1 LANE RAMP | | $54,000.00 |
| 450 | foot roadway length | |
| 22 | feet wide | |
| $120 | per foot of length | |
| 2 LANE ROADWAY | | $209,100.00 |
| 1,230 | foot roadway length | |
| 34 | feet wide | |
| $170 | per foot of length | |
| 2 LANE ROADWAY W/ ONE SIDEWALK | | $294,000.00 |
| 1,050 | foot roadway length | |
| 40 | feet wide | |
| $280 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $278,550.00 |
| NEW ROADWAY CONSTRUCTION: | | |
| 1 LANE RAMP | | $3,383,021.07 |
| 4,150 | foot roadway length | |
| 22 | feet wide | |
| $815 | per foot of length | |
| 2 LANE ROADWAY | | $1,177,943.48 |
| 935 | foot roadway length | |
| 34 | feet wide | |
| $1,260 | per foot of length | |
| 3 LANE ROADWAY | | $1,789,703.37 |
| 1,050 | foot roadway length | |
| 46 | feet wide | |
| $1,704 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $3,175,333.96 |

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### BOURNE ROTARY - ALTERNATIVE 3A - INTERCHANGE

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES BOURNE ROTARY ALTERNATE 2 WAS BUILT AS A MID-TERM IMPROVEMENT

### BOURNE ROTARY - ALTERNATIVE 3A - INTERCHANGE

**Page 2**

| | | | |
|---|---|---|---|
| STRUCTURAL: | | | |
| 2 LANE BOAT SECTION | | | $20,600,000.00 |
| 2,060 | foot roadway length | | |
| 34 | feet wide | | |
| $10,000 | per foot of length | | |
| | | | |
| 1 LANE RAMP OVER BOAT SECTION | | | $744,000.00 |
| 40 | foot roadway length | | |
| 30 | feet wide | | |
| 1,200 | square feet | | |
| $620 | per square foot of length | | |
| | | | |
| 2 LANE ROADWAY OVER BOAT SECTION | | | $1,240,000.00 |
| 40 | foot roadway length | | |
| 50 | feet wide | | |
| 2,000 | square feet | | |
| $620 | per square foot of length | | |
| | | Subtotal: | $32,945,651.88 |
| | | Contingencies* (25%): | $8,236,412.97 |
| | | **Total (2017):** | **$41,182,064.85** |
| | | **Total (2020):** | **$46,325,704.75** |
| | | **Total (2030):** | **$68,568,137.98** |
| | | **Total (2040):** | **$101,480,844.21** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | | |
| | | P.E. Design (15%): | $6,177,309.73 |
| | | Construction Engineering (15%): | $6,177,309.73 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**BOURNE ROTARY - ALTERNATIVE 3A - INTERCHANGE**

**ASSUMPTIONS:**

THIS ESTIMATE ASSUMES BOURNE ROTARY ALTERNATE 2 WAS BUILT AS A MID-TERM IMPROVEMENT

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### ROUTE 6 ADD-A-LANE

| | | |
|---|---|---|
| NEW ROADWAY CONSTRUCTION: | | |
| ROADWAY WIDENING AND TAPER (ONE LANE) | | $13,139,312.94 |
| 19,700 | foot roadway length | |
| 18 | feet wide | |
| $667 | per foot of length | |
| ROADWAY WIDENING AND TAPER (TWO LANE) | | $2,000,910.60 |
| 1,800 | foot roadway length | |
| 30 | feet wide | |
| $1,112 | per foot of length | |
| DECK WIDENING | | $468,000.00 |
| 60 | foot roadway length | |
| 12 | feet wide | |
| 720 | square feet | |
| $650 | per square foot of length | |
| 0.5 Factor for Embank., Drainage | | $7,570,111.77 |
| | Subtotal: | $23,178,335.31 |
| | Contingencies* (25%): | $5,794,583.83 |
| | **Total (2017):** | **$28,972,919.14** |
| | **Total (2020):** | **$32,591,636.74** |
| | **Total (2030):** | **$48,239,910.36** |
| | **Total (2040):** | **$71,395,067.34** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | |
| | P.E. Design (15%): | $4,345,937.87 |
| | Construction Engineering (15%): | $4,345,937.87 |

* - Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**Location 2 -Intersection of Route 6A and Cranberry Highway**

| | | | |
|---|---|---|---|
| Cranberry Highway | | | $93,000.00 |
| | 4-lane Rd, no sidewalk | | |
| 300 | foot roadway length | | |
| 58 | feet wide | | |
| $310 | per foot of length | | |
| Sandwich Road | | | $373,860.00 |
| | 2-lane Rd, 2 Sidewalks | | |
| 930 | foot roadway length | | |
| 46 | feet wide | | |
| $402 | per foot of length | | |
| 0.5 Factor for Embank., Drainage | | | $233,430.00 |
| | | Subtotal: | $466,860.00 |
| | | Contingencies* (25%): | $116,715.00 |
| | | **Total (2017):** | **$583,575.00** |
| | | **Total (2020):** | **$656,463.52** |
| | | **Total (2030):** | **$971,652.38** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | | |
| | | P.E. Design (15%): | $87,536.25 |
| | | Construction Engineering (15%): | $87,536.25 |

- Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

## CAPE COD CANAL TRANSPORTATION STUDY
## CONCEPTUAL ESTIMATES

### Location 3 - Intersection of Route 130 and Cotuit Road

| | | | |
|---|---|---|---|
| Forestdale Rd | | | $222,200.00 |
| | | 3-Lane Rd, no sidewalk | |
| | 1,010 | foot roadway length | |
| | 46 | feet wide | |
| | $220 | per foot of length | |
| Contuit Rd | | | $87,480.00 |
| | | Due to intersection widening and median, effectively a 3-lane with 2 sidewalks | |
| | 180 | foot roadway length | |
| | 58 | feet wide | |
| | $486 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | | $154,840.00 |
| Traffic Control Signal | | | $300,000.00 |
| | | Subtotal: | $764,520.00 |
| | | Contingencies* (25%): | $191,130.00 |
| | | **Total (2017):** | **$955,650.00** |
| | | **Total (2020):** | **$1,075,010.69** |
| | | **Total (2030):** | **$1,591,157.25** |
| | | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | |
| | | P.E. Design (15%): | $143,347.50 |
| | | Construction Engineering (15%): | $143,347.50 |

- Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

**CAPE COD CANAL TRANSPORTATION STUDY**
**CONCEPTUAL ESTIMATES**

**Location 4 - Intersection of Sandwich Road and Bourne Rotary Connector**

| | | |
|---|---|---|
| Old Sandwich Road | | $184,680.00 |
| | 3-Lane, 2 sidewalks | |
| 380 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| Bourne Rotary Connector | | $376,650.00 |
| | 3-Lane, 2 sidewalks | |
| 775 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| Sandwich Road | | $228,420.00 |
| | 3-Lane, 2 sidewalks | |
| 470 | foot roadway length | |
| 58 | feet wide | |
| $486 | per foot of length | |
| 0.5 Factor for Embank., Drainage | | $394,875.00 |
| Traffic Control Signal | | $300,000.00 |
| | Subtotal: | $1,484,625.00 |
| | Contingencies* (25%): | $371,156.25 |
| | **Total (2017):** | **$1,855,781.25** |
| | **Total (2020):** | **$2,087,568.33** |
| | **Total (2030):** | **$3,089,875.78** |
| | **Total (2040)** | **$4,573,016.16** |
| | **FUTURE YEARS ASSUME A 4% ANNUAL COST ESCALATION** | |
| | P.E. Design (15%): | $278,367.19 |
| | Construction Engineering (15%): | $278,367.19 |

- Contingencies may includes resource area mitigation, utility relocation, traffic management, retaining walls, etc.

# Appendix F:

# Preliminary Air Quality Evaluation

HMMH
77 South Bedford Street
Burlington, Massachusetts 01803
781.229.0707
www.hmmh.com

# MEMORANDUM

| | |
|---|---|
| **To:** | Michael Paiewonsky<br>Stantec<br>226 Causeway Street, 6th Floor, Boston, MA 02114 |
| **From:** | Philip DeVita, Principal Consultant |
| **Date:** | February 20, 2018 |
| **Subject:** | Cape Cod Canal Transportation Improvements Study<br>Preliminary Air Quality Evaluation |
| **Reference:** | HMMH Project Number 308230 |

This memorandum summarizes the methods and findings of the preliminary air quality evaluation conducted for the Cape Cod Canal Transportation Improvements Study. The evaluation was conducted based on the conceptual design of potential transportation improvements and future year (2040) traffic forecasts. As such, the study did not include roadway prediction modeling of air quality levels with the U.S. Environmental Protection Agency (EPA) and Federal Highway Administration (FHWA) approved air quality models. Instead, a more qualitative evaluation was conducted to assess the potential for increased or decreased air quality impacts within the study areas utilizing EPA and FHWA guideline criteria.

A detailed air quality study would be conducted during the preparation of an environmental document for future projects once the number of alternatives has been narrowed, and the alternatives selected for study have been refined. These future detailed air quality analysis' would evaluate existing and future air quality impacts associated with project roadways. Impacts will be assessed with respect to the methodologies and assumptions for each pollutant consistent with FHWA and EPA guidance as well as that of the Massachusetts Department of Transportation (MassDOT) and Massachusetts Department of Environmental Protection (MassDEP).

## Preliminary Air Quality Evaluation Methodology

HMMH reviewed proposed roadway improvements in connection with four future Build scenarios under study, designated Cases 1, 2, 3 and 3A. Case 3A is considered to be the most complete improvement scenario, and includes the replacement of both the Bourne and Sagamore Bridges. Case 2 represents the complete mid-term improvements, including most of the improvements in Case 3A but without the replacement of the Canal bridges, the relocation of Route 6 Exit 1C, or the addition of an additional westbound travel lane on Route 6.

Consistent with the noise approach, Case 2 and Case 3A were chosen for the air quality assessment. Modeled traffic impacts were also reviewed for the summer and non-summer conditions for each Build Scenario. It was determined the worst-case conditions (i.e. higher traffic volumes) occur during the summer peak period which would correlate to higher (i.e. worst case) air quality impacts. Therefore, HMMH assumed worst-case summer peak period traffic conditions when evaluating Case 2 and Case 3A Alternatives.

Accordingly, a qualitative carbon monoxide (CO), Mobile Source Air Toxics (MSATs), greenhouse gas (GHG), and ozone precursor's volatile organic compounds (VOCs) and nitrogen oxides (NOx) analysis have been prepared. The EPA has designated the Project Area as being in attainment for all the National Ambient Air Quality Standards (NAAQS); therefore, transportation conformity requirements do not apply for this project.

**Carbon Monoxide:** Analysis for potential impacts for CO was conducted for the roadway and associated intersections that might be impacted by the project for the Existing, future No Build, Build Case 2, and Build Case 3A conditions. Typically, CO is used in microscale studies to indicate roadway pollutant levels since it is the most abundant pollutant emitted by motor vehicles and can result in so-called "hot spot" (high concentration) locations around congested intersections.

Comparison of average daily peak hour (AM and PM) volumes and Level of Service (LOS) along with expected delay and vehicle hours traveled (VHT) at each intersection were conducted for each Alternative and are included in Table 1. A total of twelve intersections were included in the analysis, which were comprised of both existing and future intersections.

Analysis of Table 1 shows that, in general, the LOS for the Peak AM and PM conditions either stay the same or is worse for Case 2 and Case 3A when compared to the future No Build conditions. Similarly, the intersection Peak AM and PM delay, peak volumes and VHT also generally increased for the two Build Alternatives compared to the No Build conditions. There were only a few intersections where the LOS, peak hourly volumes and delay were expected to improve with the Build Conditions compared to the No build. Those intersections were:

1. Forestdale Rd & Route 6 EB Ramps Exit 2
2. Forestdale Rd & Route 6 WB Ramps Exit 2
3. Mid-Cape Connector & Sandwich Rd

The Market Basket Drive & Mid-Cape Connector intersection is also expected to show a slight VHT improvement for the AM condition only under Case 3A as well as the Canal Road & Scenic Hwy/Meetinghouse Lane intersection where a reduction in VHT is expected in the PM only under Case 2. All the remaining intersections are expected to either remain the same or result in a higher LOS, delay and VHT compared to the No Build Alternative. It should also be noted that the total VHT for all the intersections for each Build Alternative are expected to increase compared to the Existing and Future No Build Alternative, with the highest increases expected during the peak PM hours and lower increases in the AM peak hours. Figure 1 shows a comparison of the total peak AM and PM VHT for each Alternative.

Intersection selection criteria for a microscale analysis is typically based on a Level of Service ("LOS") D where the project increases traffic volumes by ten percent or greater, or if the intersection operates at LOS E or F and the project degrades conditions at the location. As is shown in Table 1, there are numerous intersections were the LOS is E or F and the project either increases the traffic volumes by ten percent or greater or the project degrades the conditions at the intersection via increase vehicles and delay.

In summary, it can therefore reasonably be concluded the Project Alternatives could increase traffic volumes and delay at most of the 12 intersections evaluated compared to the No Build Alternative, which could result in an increase of CO emissions compared to the No Build Alternative. A quantitative microscale analysis for the worst-case intersections would be conducted during the preparation of the final environmental document to determine if the project would significantly impact air quality and demonstrate compliance with the CO air quality standards.

## Table 1 Summer Peak Hour Traffic for Each Alternative

| Summer AM Peak Period | Existing | | | | Future No Build | | | | Case 2 | | | | | | Case 3e | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Signalized Intersections | Control Delay | Volume | VHT | LOS | Control Delay | Volume | VHT | LOS | Control Delay | Volume | Volumes Percent Change | VHT | Build - No Build VHT | LOS | Control Delay | Volume | Volumes Percent Change | VHT | Build -No Build VHT | LOS |
| Forestdale Rd & Rte 6EB Ramps Exit 2 | 13.7 | 1790 | 6.8 | A | 32.9 | 2215 | 20.2 | C | 41.1 | 2210 | -0.2 | 25.2 | 5.0 | C | 39.6 | 2205 | -0.5 | 24.5 | 4.0 | C |
| Forestdale Rd & Rte 6WB Ramps Exit 2 | 18.2 | 1435 | 7.3 | A | 17.1 | 1650 | 7.8 | A | 20 | 1615 | -2.1 | 9.0 | 1.1 | A | 19.9 | 1615 | -2.1 | 8.9 | 1.1 | A |
| Tupper Rd & Rte 6A | 17.7 | 980 | 4.8 | A | 18.8 | 1140 | 6.0 | A | 19.8 | 1235 | 8.3 | 6.8 | 0.8 | A | 19.9 | 1210 | 6.1 | 6.7 | 0.7 | A |
| Andy Olivia/Nightingale Pond Rd & Scenic Hwy | 8.1 | 2655 | 6.0 | A | 12.8 | 3115 | 11.1 | B | 63 | 3625 | 16.4 | 63.4 | 52.4 | E | 62.4 | 3615 | 16.1 | 62.7 | 51.6 | E |
| Canal Rd & Scenic Hwy/Meetinghouse Ln | 31.6 | 1615 | 14.2 | B | 54.3 | 1960 | 29.6 | C | 94.1 | 2275 | 16.1 | 59.5 | 29.9 | E | 101.3 | 2315 | 18.1 | 65.1 | 35.6 | E |
| Trowbridge Rd & Veteran's Way | -- | -- | -- | -- | -- | -- | -- | -- | 14.5 | 1155 | 1155.0 | 4.7 | 4.7 | A | 7.3 | 800 | 800.0 | 1.6 | 1.6 | A |
| Mid-Cape Connector & Sandwich Rd | 20.5 | 2135 | 12.2 | B | 23 | 2565 | 16.4 | B | 19.4 | 2245 | -12.5 | 12.1 | -4.3 | B | 19.8 | 2280 | -11.1 | 12.5 | -3.8 | B |
| Market Basket Dr & Mid-Cape Connector | 10.6 | 1290 | 3.8 | A | 19.5 | 1545 | 8.4 | A | 18.9 | 1585 | 2.6 | 8.3 | 0.0 | A | 15.4 | 1640 | 6.1 | 7.0 | -1.4 | A |
| Scenic Highway & Connector Road to Belmont Roundabout | -- | -- | -- | -- | -- | -- | -- | -- | 191.9 | 3715 | 3715.0 | 198.0 | 198.0 | F | 195.8 | 3705 | 3705.0 | 201.5 | 201.5 | F |
| Bourne Rotary Connector & Sandwich Rd | -- | -- | -- | -- | -- | -- | -- | -- | 0.5 | 2185 | 2185.0 | 0.3 | 0.3 | A | 10.4 | 2525 | 2525.0 | 7.3 | 7.3 | A |
| Route 3EB on-ramp/Church Ln & Scenic Hwy | 19.5 | 2000 | 10.8 | B | 21.1 | 2360 | 13.8 | B | 22.2 | 2970 | 25.8 | 18.3 | 4.5 | B | 22 | 3010 | 27.5 | 18.4 | 4.6 | B |
| Old Sandwich Rd & Veteran's Way | -- | -- | -- | -- | -- | -- | -- | -- | 16.1 | 1090 | 1090.0 | 4.9 | 4.9 | A | 19.2 | 1540 | 1540.0 | 8.2 | 8.2 | A |
| Total VHT | | | 65.8 | | | | 113.3 | | | | | 410.5 | | | | | | 424.3 | | |

| Summer PM Peak Period | Existing | | | | Future No Build | | | | Case 2 | | | | | | Case 3e | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Signalized Intersections | Control Delay | Volume | VHT | LOS | Control Delay | Volume | VHT | LOS | Control Delay | Volume | Volumes Percent Change | VHT | No Build VHT | LOS | Control Delay | Volume | Volumes Percent Change | VHT | Build -No Build VHT | LOS |
| Forestdale Rd & Rte 6EB Ramps Exit 2 | 19.8 | 2050 | 11.3 | B | 260.8 | 2675 | 198.8 | F | 311.6 | 2700 | 0.9 | 233.7 | 38.9 | F | 327.7 | 2710 | 1.3 | 246.7 | 52.9 | F |
| Forestdale Rd & Rte 6WB Ramps Exit 2 | 25.4 | 1625 | 11.5 | B | 25.4 | 1885 | 13.3 | B | 56.8 | 1905 | 1.1 | 30.1 | 16.8 | C | 52.6 | 1895 | 0.5 | 27.7 | 14.4 | C |
| Tupper Rd & Rte 6A | 24.1 | 1715 | 11.5 | B | 55 | 2125 | 32.5 | C | 63.8 | 2170 | 2.1 | 38.5 | 6.0 | D | 66.4 | 2160 | 1.6 | 39.8 | 7.4 | D |
| Andy Olivia/Nightingale Pond Rd & Scenic Hwy | 9.7 | 3060 | 8.2 | A | 127.2 | 4095 | 144.7 | F | 229.3 | 4445 | 8.5 | 283.1 | 138.4 | F | 219.1 | 4395 | 7.3 | 267.5 | 122.8 | F |
| Canal Rd & Scenic Hwy/Meetinghouse Ln | 102.8 | 1830 | 52.3 | D | 227.2 | 2670 | 168.5 | F | 186.7 | 2765 | 3.6 | 143.4 | -25.1 | F | 249.4 | 2920 | 9.4 | 202.3 | 33.8 | F |
| Trowbridge Rd & Veteran's Way | -- | -- | -- | -- | -- | -- | -- | -- | 14.6 | 1170 | 1170.0 | 4.7 | 4.7 | A | 9.7 | 695 | 695.0 | 1.9 | 1.9 | A |
| Mid-Cape Connector & Sandwich Rd | 26.2 | 2720 | 19.8 | B | 61.4 | 3360 | 57.3 | E | 27.7 | 3015 | -10.3 | 23.2 | -34.1 | C | 60.3 | 3145 | -6.4 | 52.7 | -4.6 | D |
| Market Basket Dr & Mid-Cape Connector | 14.8 | 1325 | 5.4 | A | 39.8 | 1955 | 21.6 | C | 48.9 | 2085 | 6.6 | 28.3 | 6.7 | C | 50.7 | 2250 | 15.1 | 31.7 | 10.1 | C |
| Scenic Highway & Connector Road to Belmont Roundabout | -- | -- | -- | -- | -- | -- | -- | -- | 199.9 | 4075 | 4075.0 | 226.3 | 226.3 | F | 184.4 | 4030 | 4030.0 | 206.4 | 206.4 | F |
| Bourne Rotary Connector & Sandwich Rd | -- | -- | -- | -- | -- | -- | -- | -- | 1.5 | 2920 | 2920.0 | 1.2 | 1.2 | A | 27.1 | 3520 | 3520.0 | 26.5 | 26.5 | C |
| Route 3EB on-ramp/Church Ln & Scenic Hwy | 19.1 | 2420 | 12.8 | B | 33.4 | 3265 | 30.3 | C | 52.5 | 3720 | 13.9 | 54.3 | 24.0 | D | 51.3 | 3880 | 18.8 | 55.3 | 25.0 | E |
| Old Sandwich Rd & Veteran's Way | -- | -- | -- | -- | -- | -- | -- | -- | 15.9 | 1430 | 1430.0 | 6.3 | 6.3 | A | 10.8 | 2105 | 2105.0 | 6.3 | 6.3 | A |
| Total VHT | | | 132.8 | | | | 662.0 | | | | | 1073.1 | | | | | | 1164.8 | | |

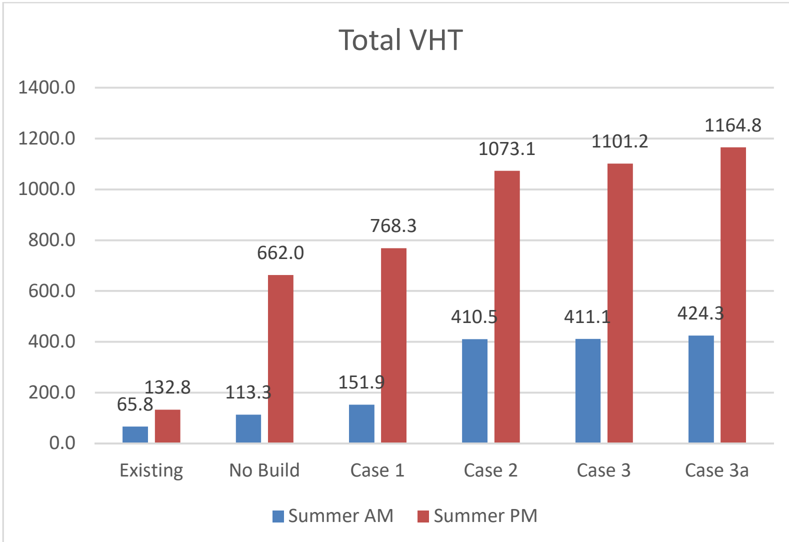



**Figure 1 Total Peak Hour VHT for Each Alternative**

**Mobile Source Air Toxics:** The analysis qualitatively evaluated potential impacts from Mobile Source Air Toxics (MSATs) in the Study Area. As the Build Alternatives are not anticipated to add significant capacity to the existing and/or proposed new roadway networks, where design year traffic is projected to be 140,000 to 150,000 annual average traffic (AADT) or greater, the Build Alternatives are best characterized as ones with "Low Potential MSAT Effects" under the 2016 FHWA interim guidance update document[1].

For each alternative, the amount of MSATs emitted would be proportional to the vehicle miles traveled (VMT) which is a function of distance and average daily traffic (ADT), assuming that other variables such as fleet mix are the same for each Alternative. As shown in Table 2, the ADT estimated for each of the Build Alternatives is slightly higher than that for the No Build Alternative, because the additional capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network. The increase in ADT, which will result in an increase in VMT, would lead to overall higher MSAT emissions in the study area for the Build Alternatives, however as shown in the Table 2, there may be localized areas where VMT would increase and other areas where VMT would decrease. Therefore, it is possible that localized increases and decreases in MSAT emissions may occur for both Build Alternatives. For example, the localized increases in MSAT emissions would likely be most pronounced along the Bourne Bridge, sections of Route 3, sections of Route 6, Route 25, Route 28, and Route 130, the Bourne Bridge Off-ramp to Belmont Circle, and the mid Cape Connector on ramp to Route 6 EB.

MSAT decreases could be expected but not limited to areas along the Sagamore Bridge, portions of Route 3 southbound, portions of Sandwich Road and Adams Street, Belmont Circle, portions of Route 25 and Route 6, portions of Main Street, Herring Pond Onramp, Cranberry Highway On-Ramp, Maple Springs Road Onramp, Route 25 EB Off Ramp, and Scenic Highway Westbound Onramp. The emissions increase may be offset somewhat by lower MSAT emission rates due to increased speeds according to the EPA MOVES2014 model where emissions of all the priority MSATs decrease as speed increases.

[1] https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/

**Table 2 Summer Adjusted ADT for Each Alternative**

| ATR Counting Stations | Summer 2014 Summer Adjusted ADT | Future No Build Summer Summer Adjusted ADT | 2040 Build - Case 2: ADT Volumes Summer Adjusted ADT | Delta Change - Case 2 vs Future No Build | 2040 Build - Case 3A: ADT Volumes Summer Adjusted ADT | Delta Change - Case 3A vs Future No Build |
|---|---|---|---|---|---|---|
| Bourne Bridge | 56,500 | 61,600 | 69,600 | 8,000 | 72,900 | 11,300 |
| Sagamore Bridge | 65,900 | 93,300 | 88,700 | -4,600 | 85,300 | -8,000 |
| Route 3 SB Off Ramp To Herring Pond Road | 4,600 | 7,900 | 6,200 | -1,700 | 6,300 | -1,600 |
| Route 3 SB Off Ramp To Scenic Highway | 3,400 | 5,000 | 7,700 | 2,700 | 7,700 | 2,700 |
| Route 3 between Exits 1A and 2 | 46,500 | 72,400 | 79,000 | 6,600 | 77,500 | 5,100 |
| Route 6 Between Exits 1 & 2 | 72,300 | 90,600 | 91,700 | 1,100 | 92,400 | 1,800 |
| Route 25 west of Exit 2 | 62,900 | 78,900 | 84,800 | 5,900 | 85,000 | 6,100 |
| Route 25 east of Exit 2 | 24,500 | 26,200 | 32,800 | 6,600 | 33,000 | 6,800 |
| Route 6A East of Tupper Road | 12,400 | 15,100 | 14,700 | -400 | 14,400 | -700 |
| Route 6 (Scenic Hwy) east of Nightingale Rd | 33,600 | 36,200 | 47,900 | 11,700 | 47,500 | 11,300 |
| Sandwich Rd East of Bourne Rotary Connector | 30,800 | 33,400 | 31,100 | -2,300 | 32,200 | -1,200 |
| Sandwich Road west of Jillian Drive | 31,200 | 34,600 | 33,200 | -1,400 | 34,300 | -300 |
| Sandwich Road East of Adams Street | 11,700 | 14,900 | 15,700 | 800 | 15,100 | 200 |
| Adams Street South of Sandwich Road | 7,600 | 11,800 | 1,100 | -10,700 | 1,000 | -10,800 |
| Belmont Circle On Ramp to Bourne Bridge | 8,600 | 11,800 | 10,300 | -1,500 | 10,200 | -1,600 |
| Belmont Circle On Ramp to Route 25 WB | 12,100 | 12,200 | 3,400 | -8,800 | 3,400 | -8,800 |
| Bourne Bridge Off Ramp to Belmont Circle | 7,200 | 7,100 | 11,700 | 4,600 | 12,600 | 5,500 |
| Buzzards Bay Bypass | 7,900 | 8,800 | 8,500 | -300 | 8,600 | -200 |
| Cranberry Highway On Ramp to Route 6 WB | 6,500 | 11,100 | 7,000 | -4,100 | 6,100 | -5,000 |
| Glen Charlie Road On Ramp to Route 25 EB | 2,200 | 2,000 | 2,400 | 400 | 2,500 | 500 |
| Main Street West of Perry Avenue | 25,600 | 28,500 | 26,800 | -1,700 | 26,800 | -1,700 |
| Mid-Cape Connector South of Sandwich Rd | 19,100 | 28,500 | 30,100 | 1,600 | 32,600 | 4,100 |
| Route 151 On Ramp to Route 28 NB | | 5500 | 6800 | 1,300 | 6800 | 1,300 |
| Route 151 On Ramp to Route 28 SB | | 1,600 | 2,400 | 800 | 2,300 | 700 |
| Route 28 NB Off Ramp to Route 151 | | 600 | 1500 | 900 | 1500 | 900 |
| Route 28 SB Off Ramp to Route 151 | | 5500 | 7300 | 1,800 | 7300 | 1,800 |
| Route 25 EB Off Ramp to Belmont Circle | 9,000 | 11,200 | 13,500 | 2,300 | 11,900 | 700 |
| Route 25 EB Off Ramp to Maple Springs Rd | 7,300 | 14,800 | 11,300 | -3,500 | 11,000 | -3,800 |
| Route 3 NB Off Ramp to Herring Pond Road | 1,800 | 3,100 | 3,700 | 600 | 3,700 | 600 |
| Route 6 EB Off Ramp to Mid-Cape Connector | 5,900 | 8,600 | 8,600 | 0 | 8,100 | -500 |
| Route 6 EB Off Ramp to Quaker Meeting House Rd | 1,300 | 1,700 | 1,700 | 0 | 1,800 | 100 |
| Route 6 EB Off Ramp to Route 130 | 7,000 | 15,700 | 19,600 | 3,900 | 20,000 | 4,300 |
| Route 6 WB Off Ramp to Cranberry Hwy | 5,500 | 3,800 | 4,400 | 600 | 4,500 | 700 |
| Route 6 WB Off Ramp to Meetinghouse Lane EB | 4,700 | 4,500 | 4,600 | 100 | 4,600 | 100 |
| Route 6 WB Off Ramp to Quaker Meetinghouse Rd | 1,000 | 2,300 | 1,600 | -700 | 1,600 | -700 |
| Route 6 WB Off Ramp to Route 130 | 2,200 | 2,000 | 2,000 | 0 | 1,900 | -100 |
| Route 6 WB Off Ramp to Scenic Hwy WB | 11,800 | 13,400 | 13,800 | 400 | 13,800 | 400 |
| Herring Pond Road On Ramp to Route 3 NB | 4,400 | 5,500 | 5,700 | 200 | 5,600 | 100 |
| Herring Pond Road On Ramp to Route 3 SB | 2,500 | 7,800 | 6,700 | -1,100 | 6,700 | -1,100 |
| Maple Springs Rd On Ramp to Route 25 WB | 6,900 | 11,000 | 8,900 | -2,100 | 9,000 | -2,000 |
| Mid Cape Connector On Ramp to Route 6 EB | 12,500 | 12,500 | 13,500 | 1,000 | 16,000 | 3,500 |
| Quaker Meeting House Rd On Ramp to 6 EB | 2,700 | 4,400 | 3,900 | -500 | 3,800 | -600 |
| Quaker Meeting House Rd On Ramp to Route 6 WB | 1,000 | 1,100 | 1,600 | 500 | 1,600 | 500 |
| Route 130 North of Route 6 | 12,200 | 12,500 | 11,300 | -1,200 | 11,400 | -1,100 |
| Route 130 On Ramp to Route 6 EB | 2300 | 1800 | 1400 | -400 | 1400 | -400 |
| Route 130 South of Route 6 | 24,500 | 28,600 | 32,300 | 3,700 | 32,200 | 3,600 |
| Route 130 On Ramp to Route 6 WB | 9,400 | 12,300 | 15,300 | 3,000 | 15,100 | 2,800 |
| Scenic Hwy EB On Ramp to Sagamore Bridge | 9400 | 11100 | 9900 | -1,200 | 8100 | -3,000 |
| Scenic Hwy WB On Ramp to Sagamore Bridge | 3600 | 6700 | 4000 | -2,700 | 3800 | -2,900 |
| State Road North of Ramp to Route 3 NB | 5700 | 8200 | 8300 | 100 | 8400 | 200 |
| Trowbridge Road West of Veterans Way | 7300 | 12000 | 10100 | -1,900 | 4400 | -7,600 |
| NEW Belmont Circle On Ramp to Route 25 WB | | | | 0 | | 0 |
| | Totals | 921,700 | 940,100 | 18,400 | 935,700 | 14,000 |
| | Change | | 1.99 | | 1.52 | |

Regardless of the option chosen, emissions will likely be lower than present levels in the design year as a result of EPA's national control programs that are projected to reduce annual MSAT emissions by over 90 percent 2010 and 2050. Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

**Mesoscale Analysis:** A mesoscale analysis is typically performed to calculate the potential regional air quality impact of the project using as a measure the total daily emissions of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) within the project area. Calculations are typically performed to compare area-wide emissions for future Build scenarios with the Existing and future No-Build conditions. Typically, emission factors for each pollutant are generated for each roadway link using the EPA emission models based on vehicle miles traveled, vehicle speeds and other roadway data relative to the Project. Table 2 shows the summer adjusted ADT for the Existing, future No Build and Build Alternatives affected links. As discussed above in the MSAT section, Summer ADT is expected to slightly increase with the Build Alternatives compared to the future No-Build Alternative. As a result, overall emissions of VOCs and NOx could also slightly increase with the Build Alternatives. Similar to the MSAT analysis, there are localized areas where increases and decreases could occur and some increases may be mitigated due to increased vehicle speeds. Given the relatively small expected ADT increase associated with the Build Alternatives of approximately 2.0 percent and 1.5 percent relative to the total VMT's in the region, it is unlikely that this portion of the project would result in a substantial change in emissions or any subsequent direct or indirect impacts to the mesoscale analysis. A quantitative mesoscale analysis will be conducted during the preparation of the final environmental document, once the number of alternatives has been narrowed, and the alternatives selected for study have been refined.

**Greenhouse Gases:** The transportation system is a critical component of the Commonwealth of Massachusetts' infrastructure and contributes over one third of the Bay State's greenhouse gas (GHG) emissions. The Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, released the Massachusetts Clean Energy and Climate Plan for 2020. This implementation plan establishes targets for overall, statewide GHG emissions:

- By 2020, 20 percent reduction below statewide 1990 GHG emission levels;
- By 2050, 80 percent reduction below statewide 1990 GHG emission levels

In 2010, the Massachusetts Department of Transportation (MassDOT) responded to these challenges by launching the GreenDOT Policy. GreenDOT was developed to reduce GHG emissions, improving public health, and leading on environmental stewardship. In addition, Executive Orders 484 *Leading by Example* and 515 *Environmental Purchasing Policy*, require state agencies to invest public resources in ways that support environmental sustainability by conserving energy and water, implementing efficiency measures, and producing or purchasing renewable energy. Taken together, these acts and policies form the foundation for the GreenDOT Policy. The GreenDOT Policy Directive, released in June 2010, set forth the primary goals of reducing GHG emissions; promoting the healthy transportation modes of walking, bicycling, and public transit; and supporting smart growth development. The Cape Cod Regional Transportation Plan (RTP) reflects the vision of the GreenDOT Policy with the Multimodal Options/Healthy Transportation Goal, including a *Performance Measure* reflecting the state Mode Shift Goal. The Cape Cod Commission conducted a GHG analysis as part of the 2016 Regional Transportation Plan[2]. Anticipated GHG impacts from nine specific regional target projects were conducted. Two of those projects, 1) Belmont Circle/Route 25 Ramp Improvements and 2) Route 6 Exit 1C reconfiguration were included in the GHG analysis. The results of the anticipated GHG impacts from these two projects were documented as "quantified decrease in emissions from traffic operation improvement-to be verified by statewide modeling". Similarly, any increase or decreases in GHG emissions for the Build

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2 http://www.capecodcommission.org/resources/transportation/rtp/2016/FinalReport/Appendices/RTP%20Appendix%20N%20-%20Greenhouse%20Gas%20Analysis%20(Endorsed%207-20-15).pdf

Alternatives would need to be quantified in the final environmental document to account for VMT and vehicle speeds for the Build Alternatives compared to the No Build.

# Appendix G:

# Preliminary Noise Evaluation

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## MEMORANDUM

| | |
|---|---|
| **To:** | Michael Paiewonsky, Stantec |
| **From:** | Christopher Menge |
| **Date:** | November 16, 2017 |
| **Subject:** | Cape Cod Canal Transportation Improvements Study<br>Preliminary Noise Evaluation |
| **Reference:** | HMMH Project No. 308230 |

This memorandum summarizes the methods and findings of the preliminary noise evaluation conducted for the Cape Cod Canal Transportation Improvements Study. The noise evaluation was conducted with preliminary information about the potential location of future roadways and preliminary traffic forecasts. As such, the study did not include roadway modeling, prediction of noise levels with the Traffic Noise Model or noise impact assessment per the FHWA Noise Abatement Criteria. Instead, a more qualitative evaluation was conducted to assess the potential for increased noise levels in the noise-sensitive residential neighborhoods in the study areas.

A detailed noise study will be conducted during the preparation of the final environmental document for this project, once the number of alternatives has been narrowed, and the alternatives selected for study have been refined. This future detailed noise analysis will predict existing and future noise levels and impact associated with project roadways. Impact will be assessed with respect to the FHWA Noise Abatement Criteria, which are absolute sound levels above which noise impact is assessed and for which noise abatement must be considered. Impact will also be assessed with respect to relative criteria – identifying any areas with Substantial Increases in existing noise levels. In that study, where future Build case noise impact is identified noise abatement will be considered, and evaluated for feasibility and cost-reasonableness.

## Preliminary Noise Evaluation Methodology

HMMH reviewed proposed roadway improvements in connection with four future Build scenarios under study, designated Cases 1, 2, 3 and 3a. Case 3a is considered to be the most complete long-term improvements scenario, and includes the replacement of both the Bourne and Sagamore Bridges. Case 2 represents mid-term improvements, including most of the improvements in Case 3a but without the replacement of the Canal bridges. Therefore, HMMH focused on evaluating these two cases to provide evaluations of worst-case potential increases in noise levels as well as a mid-term improvement scenario.

FHWA and MassDOT regulations and policies require noise assessments to evaluate future equivalent ($L_{eq}$) noise levels (in dBA) during the loudest hour of the day. To address these conditions, HMMH examined the traffic projections provided by Stantec for the non-summer weekday AM and PM peak hours and for the summer Saturday peak hour. The volumes were provided for the Existing year of 2014 and forecast to 2040 for the Build cases. For roads near noise-sensitive (mostly residential) areas, the Existing year peak-hour volumes were compared to the 2040 volumes for the same roadways in Cases 2 and 3a. Then, the sound level increase in decibels based on volumes alone was computed with the following equation:

$$Incr = 10 \times \log(\frac{V_{2040}}{V_{2014)}}), \qquad \text{where}$$

$V_{2014}$ is the existing 2014 volume, and $V_{2040}$ is the 2040 design-year Build case volume. This simple computation assumes three factors are not changing – speed, truck mix and distance to the nearest noise-sensitive properties. Those assumptions are reasonable for nearly all areas, but distances would be different in some areas where the roadways would be moved. That is particularly significant in Case 3a with Route 28 being relocated to the east, north and south of the Bourne Rotary. In those areas, the change in distance was accounted for with a customary sound propagation equation.

The increases in the hourly $L_{eq}$ sound level from the 2014 Existing to 2040 Build conditions were computed for all three peak hours for Cases 2 and 3a. The range of increases and the peak hour with the highest increase are reported for the areas near residential land use. For reference, a sound level increase of 3 decibels (dB) or less is considered to be generally not noticeable under most circumstances. An increase of 5 dB is considered to be generally noticeable in a community setting. An increase of 10 dB is perceived by most people as about twice as loud. Also, MassDOT noise policy considers an increase of 10 dB or more above existing noise levels to be a “Substantial Increase.” This is considered to be a relative noise impact that would require consideration of abatement in a final environmental document.

## Results

Table 1 lists average or ranges of predicted $L_{eq}$ sound level increases for the three peak hours from the Existing 2014 case traffic to the 2040 Build condition for Cases 2 and 3a. The average increase is shown where the range is small. Each row shows the information for one roadway that has some noise-sensitive land use adjacent to it. Most of that land use is single-family residential homes. The roadways in each project area are grouped together.

The predicted sound level increases are small for most roadways, generally less than 3 decibels, and would be expected to be generally not noticeable. However, due to expected changes in traffic patterns, the Head of the Bay road adjacent to Belmont Circle is predicted to experience up to four-fold increases in traffic volumes in both Cases 2 and 3a, which would result in increases up to six decibels. These are expected to be readily noticeable, but not approach a Substantial Increase per MassDOT policy.

The communities potentially most affected by proposed changes at the Bourne Rotary are west of Route 28, north and south of the rotary. Small increases of up to one decibel are predicted from Route 28 traffic in Case 2, which proposes minor improvements to the rotary. In Build Case 3a, however, the Bourne Bridge (carrying Rt. 28) would be replaced with a structure to the east, which would increase the distance from the bridge to the community to the west. The rotary itself would be replaced by a grade-separated (fly-over) interchange. The proposed re-alignment of Route 28 to the east of the existing roadway would also increase the distance to the homes and Bourne Middle School and fields to the west. These roadway shifts away from the communities would compensate for the predicted increases in traffic such that north of the rotary, a decrease of up to two decibels from Route 28 traffic noise is predicted, and south of the rotary, no change or a very small change in sound levels is expected.

The two far-right columns in Table 1 show the peak hour during which the highest sound level increase is predicted to occur. That part of the table clearly shows that the summer weekday PM peak hour is the period during which most of the highest increases are expected. There are a small

number of roadways where the Saturday peak hour would have a higher Build case increase over Existing.

While absolute noise levels were not computed in this preliminary evaluation, the potential for existing and future absolute noise impact from noise levels exceeding the FHWA Noise Abatement Criteria exists primarily in the yards of the first row of homes adjacent to project roadways. Absolute noise levels and associated impact will be addressed in the detailed noise study to be conducted for the final environmental document.

*Table 1 Predicted Increases in Peak Hour Noise Levels from Project Roadways from Existing 2014 to Future 2040 Build Case Conditions*

| Project Area | Community Area (Residences unless otherwise indicated) | Increases over Existing $L_{eq}$ among three peak hours (decibels) | | Build Peak Hour with Highest Increase over the Existing $L_{eq}$ | |
|---|---|---|---|---|---|
| | | Case 2 | Case 3a | Case 2 | Case 3a |
| Rt 6 Additional EB lane | North and south of Route 6, east of Exit 2 | 0 to 1 | 0 to 1 | PM | PM |
| | North of Route 6, west of Exit 2 | 1 | 1 | PM | PM |
| | North of Route 6, west of Exit 1C | 1 | 1 | Sat | PM |
| Exit 1C Roundabout | Rt. 6A east of roundabout | 1 to 3 | 1 to 3 | PM/Sat | Sat |
| | Main St SE of roundabout | 1 | 1 | PM | PM |
| Bourne Rotary | West of the Bourne Bridge opposite Rt. 28, North of the Rotary | 0 to 1 | minus 1 to minus 2 (road shifts away) | PM | PM |
| | Homes and Bourne Middle School fields west of Rt. 28, south of the rotary | 1/2 to 1 | no change (road shifts away) | Sat | Sat |
| Belmont Circle | Nightingale Rd, east of Rt. 28 | 1 to 2 | 2 | PM | PM |
| | Head of the Bay Road | 4 to 6 | 4 to 6 | PM | PM |

*Source: HMMH, 2017*

# Appendix H:
# Traffic Analysis Reports

# Short-Term Intersections

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 375 | 10 | 525 | 425 | 5 | 295 |
| Future Volume (vph) | 375 | 10 | 525 | 425 | 5 | 295 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.996 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1855 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1855 | 0 | 1770 | 1863 | 1770 | 1583 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 408 | 11 | 571 | 462 | 5 | 321 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 419 | 0 | 571 | 462 | 5 | 321 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 62.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 375 | 10 | 525 | 425 | 5 | 295 |
| Future Volume (Veh/h) | 375 | 10 | 525 | 425 | 5 | 295 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 408 | 11 | 571 | 462 | 5 | 321 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 419 | | 2018 | 414 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 419 | | 2018 | 414 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 50 | | 84 | 50 |
| cM capacity (veh/h) | | | 1140 | | 32 | 639 |

| Direction, Lane # | NB 1 | SB 1 | SB 2 | NW 1 | NW 2 |
|---|---|---|---|---|---|
| Volume Total | 419 | 571 | 462 | 5 | 321 |
| Volume Left | 0 | 571 | 0 | 5 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 321 |
| cSH | 1700 | 1140 | 1700 | 32 | 639 |
| Volume to Capacity | 0.25 | 0.50 | 0.27 | 0.16 | 0.50 |
| Queue Length 95th (ft) | 0 | 72 | 0 | 12 | 71 |
| Control Delay (s) | 0.0 | 11.3 | 0.0 | 137.1 | 16.2 |
| Lane LOS | | B | | F | C |
| Approach Delay (s) | 0.0 | 6.2 | | 18.0 | |
| Approach LOS | | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 6.9 | | |
| Intersection Capacity Utilization | 62.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 7 |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 375 | 10 | 525 | 425 | 5 | 295 |
| Future Vol, veh/h | 375 | 10 | 525 | 425 | 5 | 295 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 0 | - | 0 | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 408 | 11 | 571 | 462 | 5 | 321 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 418 | 0 | 2016 | 413 |
| Stage 1 | - | - | - | - | 413 | - |
| Stage 2 | - | - | - | - | 1603 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.42 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.42 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.42 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.518 | 3.318 |
| Pot Cap-1 Maneuver | - | - | 1141 | - | 64 | 639 |
| Stage 1 | - | - | - | - | 668 | - |
| Stage 2 | - | - | - | - | 181 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1141 | - | 32 | 639 |
| Mov Cap-2 Maneuver | - | - | - | - | 32 | - |
| Stage 1 | - | - | - | - | 668 | - |
| Stage 2 | - | - | - | - | 90 | - |

| Approach | NB | SB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 6.2 | 18.3 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | NBT | NBR | NWLn1 | NWLn2 | SBL | SBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | 32 | 639 | 1141 | - |
| HCM Lane V/C Ratio | - | - | 0.17 | 0.502 | 0.5 | - |
| HCM Control Delay (s) | - | - | 139.2 | 16.2 | 11.3 | - |
| HCM Lane LOS | - | - | F | C | B | - |
| HCM 95th %tile Q(veh) | - | - | 0.5 | 2.8 | 2.9 | - |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 365 | 10 | 355 | 370 | 10 | 445 |
| Future Volume (vph) | 365 | 10 | 355 | 370 | 10 | 445 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.996 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1855 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1855 | 0 | 1770 | 1863 | 1770 | 1583 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 397 | 11 | 386 | 402 | 11 | 484 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 408 | 0 | 386 | 402 | 11 | 484 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 54.0% ICU Level of Service A

Analysis Period (min) 15

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 365 | 10 | 355 | 370 | 10 | 445 |
| Future Volume (Veh/h) | 365 | 10 | 355 | 370 | 10 | 445 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 397 | 11 | 386 | 402 | 11 | 484 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 408 | | 1576 | 402 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 408 | | 1576 | 402 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 66 | | 86 | 25 |
| cM capacity (veh/h) | | | 1151 | | 80 | 648 |

| Direction, Lane # | NB 1 | SB 1 | SB 2 | NW 1 | NW 2 |
|---|---|---|---|---|---|
| Volume Total | 408 | 386 | 402 | 11 | 484 |
| Volume Left | 0 | 386 | 0 | 11 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 484 |
| cSH | 1700 | 1151 | 1700 | 80 | 648 |
| Volume to Capacity | 0.24 | 0.34 | 0.24 | 0.14 | 0.75 |
| Queue Length 95th (ft) | 0 | 37 | 0 | 11 | 167 |
| Control Delay (s) | 0.0 | 9.7 | 0.0 | 56.9 | 25.1 |
| Lane LOS | | A | | F | D |
| Approach Delay (s) | 0.0 | 4.8 | | 25.8 | |
| Approach LOS | | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 9.8 | | |
| Intersection Capacity Utilization | 54.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 9.7 |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 365 | 10 | 355 | 370 | 10 | 445 |
| Future Vol, veh/h | 365 | 10 | 355 | 370 | 10 | 445 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 0 | - | 0 | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 397 | 11 | 386 | 402 | 11 | 484 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 408 | 0 | 1576 | 402 |
| Stage 1 | - | - | - | - | 402 | - |
| Stage 2 | - | - | - | - | 1174 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.42 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.42 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.42 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.518 | 3.318 |
| Pot Cap-1 Maneuver | - | - | 1151 | - | 121 | 648 |
| Stage 1 | - | - | - | - | 676 | - |
| Stage 2 | - | - | - | - | 294 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1151 | - | 80 | 648 |
| Mov Cap-2 Maneuver | - | - | - | - | 80 | - |
| Stage 1 | - | - | - | - | 676 | - |
| Stage 2 | - | - | - | - | 195 | - |

| Approach | NB | SB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 4.7 | 25.8 |
| HCM LOS | | | D |

| Minor Lane/Major Mvmt | NBT | NBR | NWLn1 | NWLn2 | SBL | SBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | 80 | 648 | 1151 | - |
| HCM Lane V/C Ratio | - | - | 0.136 | 0.746 | 0.335 | - |
| HCM Control Delay (s) | - | - | 57 | 25.1 | 9.7 | - |
| HCM Lane LOS | - | - | F | D | A | - |
| HCM 95th %tile Q(veh) | - | - | 0.4 | 6.7 | 1.5 | - |

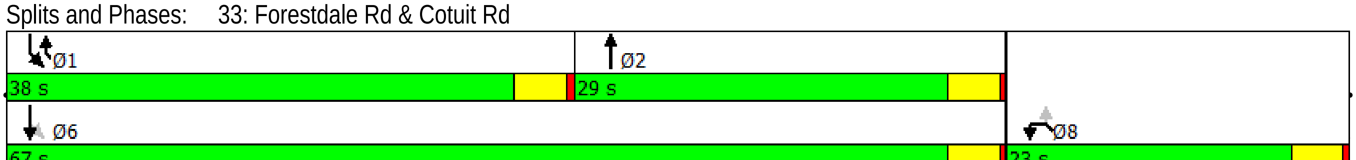
| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 635 | 500 | 5 | 375 |
| Future Volume (vph) | 475 | 10 | 635 | 500 | 5 | 375 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.217 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 404 | 1863 | 1770 | 1583 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 1 | | | | | 92 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 690 | 543 | 5 | 408 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 527 | 0 | 690 | 543 | 5 | 408 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Detector Phase | 2 | | 1 | 6 | 8 | 1 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 20.0 | 8.0 |
| Total Split (s) | 29.0 | | 38.0 | 67.0 | 23.0 | 38.0 |
| Total Split (%) | 32.2% | | 42.2% | 74.4% | 25.6% | 42.2% |
| Maximum Green (s) | 25.0 | | 34.0 | 63.0 | 19.0 | 34.0 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | Lag | | Lead | | | Lead |
| Lead-Lag Optimize? | Yes | | Yes | | | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | None | None |
| Walk Time (s) | 5.0 | | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | | | 0 | 0 | |
| Act Effct Green (s) | 25.6 | | 55.2 | 58.6 | 5.9 | 27.2 |
| Actuated g/C Ratio | 0.42 | | 0.91 | 0.96 | 0.10 | 0.45 |
| v/c Ratio | 0.68 | | 0.74 | 0.30 | 0.03 | 0.54 |
| Control Delay | 23.3 | | 12.2 | 1.1 | 30.2 | 11.4 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 23.3 | | 12.2 | 1.1 | 30.2 | 11.4 |
| LOS | C | | B | A | C | B |
| Approach Delay | 23.3 | | | 7.3 | 11.7 | |
| Approach LOS | C | | | A | B | |
| Queue Length 50th (ft) | 146 | | 79 | 0 | 2 | 75 |
| Queue Length 95th (ft) | #418 | | 299 | 70 | 12 | 135 |
| Internal Link Dist (ft) | 1369 | | | 820 | 296 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 779 | | 1145 | 1791 | 564 | 983 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.68 | | 0.60 | 0.30 | 0.01 | 0.42 |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 60.9
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 12.0 Intersection LOS: B
Intersection Capacity Utilization 74.1% ICU Level of Service D
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 33: Forestdale Rd & Cotuit Rd



| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 635 | 500 | 5 | 375 |
| Future Volume (vph) | 475 | 10 | 635 | 500 | 5 | 375 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1857 | | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.22 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1857 | | 404 | 1863 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 690 | 543 | 5 | 408 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 54 |
| Lane Group Flow (vph) | 526 | 0 | 690 | 543 | 5 | 354 |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Actuated Green, G (s) | 25.7 | | 55.2 | 55.2 | 1.0 | 26.5 |
| Effective Green, g (s) | 25.7 | | 55.2 | 55.2 | 1.0 | 26.5 |
| Actuated g/C Ratio | 0.40 | | 0.86 | 0.86 | 0.02 | 0.41 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 743 | | 889 | 1601 | 27 | 752 |
| v/s Ratio Prot | 0.28 | | c0.31 | 0.29 | 0.00 | c0.19 |
| v/s Ratio Perm | | | c0.36 | | | 0.04 |
| v/c Ratio | 0.71 | | 0.78 | 0.34 | 0.19 | 0.47 |
| Uniform Delay, d1 | 16.1 | | 9.6 | 0.9 | 31.2 | 13.7 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.1 | | 4.3 | 0.1 | 3.3 | 0.5 |
| Delay (s) | 19.2 | | 13.9 | 1.0 | 34.5 | 14.2 |
| Level of Service | B | | B | A | C | B |
| Approach Delay (s) | 19.2 | | | 8.2 | 14.5 | |
| Approach LOS | B | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.1 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.83 | | |
| Actuated Cycle Length (s) | 64.2 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 74.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 475 | 10 | 635 | 500 | 5 | 375 |
| Future Volume (veh/h) | 475 | 10 | 635 | 500 | 5 | 375 |
| Number | 2 | 12 | 1 | 6 | 3 | 18 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1900 | 1863 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 516 | 11 | 690 | 543 | 5 | 408 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 560 | 12 | 740 | 1319 | 341 | 858 |
| Arrive On Green | 0.31 | 0.31 | 0.35 | 0.71 | 0.19 | 0.19 |
| Sat Flow, veh/h | 1817 | 39 | 1774 | 1863 | 1774 | 1583 |
| Grp Volume(v), veh/h | 0 | 527 | 690 | 543 | 5 | 408 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1856 | 1774 | 1863 | 1774 | 1583 |
| Q Serve(g_s), s | 0.0 | 21.9 | 24.3 | 9.6 | 0.2 | 12.7 |
| Cycle Q Clear(g_c), s | 0.0 | 21.9 | 24.3 | 9.6 | 0.2 | 12.7 |
| Prop In Lane | | 0.02 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 572 | 740 | 1319 | 341 | 858 |
| V/C Ratio(X) | 0.00 | 0.92 | 0.93 | 0.41 | 0.01 | 0.48 |
| Avail Cap(c_a), veh/h | 0 | 580 | 874 | 1468 | 422 | 930 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 0.0 | 26.7 | 18.2 | 4.8 | 26.2 | 11.3 |
| Incr Delay (d2), s/veh | 0.0 | 20.1 | 15.1 | 0.2 | 0.0 | 0.4 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 14.3 | 17.5 | 4.9 | 0.1 | 5.6 |
| LnGrp Delay(d),s/veh | 0.0 | 46.9 | 33.3 | 5.0 | 26.2 | 11.7 |
| LnGrp LOS | | D | C | A | C | B |
| Approach Vol, veh/h | 527 | | | 1233 | 413 | |
| Approach Delay, s/veh | 46.9 | | | 20.9 | 11.9 | |
| Approach LOS | D | | | C | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | | | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 32.0 | 28.6 | | | | 60.6 | | 19.4 |
| Change Period (Y+Rc), s | 4.0 | 4.0 | | | | 4.0 | | 4.0 |
| Max Green Setting (Gmax), s | 34.0 | 25.0 | | | | 63.0 | | 19.0 |
| Max Q Clear Time (g_c+I1), s | 26.3 | 23.9 | | | | 11.6 | | 14.7 |
| Green Ext Time (p_c), s | 1.7 | 0.7 | | | | 9.2 | | 0.6 |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 25.5 |
| HCM 2010 LOS | | | C |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 485 | 10 | 445 | 400 | 10 | 525 |
| Future Volume (vph) | 485 | 10 | 445 | 400 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.212 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 395 | 1863 | 1770 | 1583 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 2 | | | | | 144 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 527 | 11 | 484 | 435 | 11 | 571 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 538 | 0 | 484 | 435 | 11 | 571 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Detector Phase | 2 | | 1 | 6 | 8 | 1 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 20.0 | 8.0 |
| Total Split (s) | 28.0 | | 22.0 | 50.0 | 20.0 | 22.0 |
| Total Split (%) | 40.0% | | 31.4% | 71.4% | 28.6% | 31.4% |
| Maximum Green (s) | 24.0 | | 18.0 | 46.0 | 16.0 | 18.0 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | Lag | | Lead | | | Lead |
| Lead-Lag Optimize? | Yes | | Yes | | | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | None | None |
| Walk Time (s) | 5.0 | | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | | | 0 | 0 | |
| Act Effct Green (s) | 18.8 | | 39.4 | 43.0 | 6.2 | 17.9 |
| Actuated g/C Ratio | 0.42 | | 0.87 | 0.95 | 0.14 | 0.40 |
| v/c Ratio | 0.70 | | 0.58 | 0.25 | 0.05 | 0.80 |
| Control Delay | 17.8 | | 7.8 | 1.2 | 22.1 | 19.0 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 17.8 | | 7.8 | 1.2 | 22.1 | 19.0 |
| LOS | B | | A | A | C | B |
| Approach Delay | 17.8 | | | 4.6 | 19.0 | |
| Approach LOS | B | | | A | B | |
| Queue Length 50th (ft) | 105 | | 14 | 0 | 3 | 92 |
| Queue Length 95th (ft) | #279 | | 161 | 58 | 16 | 219 |
| Internal Link Dist (ft) | 1369 | | | 820 | 296 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 1042 | | 922 | 1753 | 661 | 800 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.52 | | 0.52 | 0.25 | 0.02 | 0.71 |

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 45.2
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 12.2 Intersection LOS: B
Intersection Capacity Utilization 65.3% ICU Level of Service C
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 33: Forestdale Rd & Cotuit Rd

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 485 | 10 | 445 | 400 | 10 | 525 |
| Future Volume (vph) | 485 | 10 | 445 | 400 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1858 | | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.21 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1858 | | 395 | 1863 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 527 | 11 | 484 | 435 | 11 | 571 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 92 |
| Lane Group Flow (vph) | 537 | 0 | 484 | 435 | 11 | 479 |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Actuated Green, G (s) | 19.0 | | 39.3 | 39.3 | 1.0 | 17.3 |
| Effective Green, g (s) | 19.0 | | 39.3 | 39.3 | 1.0 | 17.3 |
| Actuated g/C Ratio | 0.39 | | 0.81 | 0.81 | 0.02 | 0.36 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 730 | | 785 | 1515 | 36 | 698 |
| v/s Ratio Prot | c0.29 | | 0.21 | 0.23 | 0.01 | c0.23 |
| v/s Ratio Perm | | | 0.29 | | | 0.07 |
| v/c Ratio | 0.74 | | 0.62 | 0.29 | 0.31 | 0.69 |
| Uniform Delay, d1 | 12.5 | | 5.8 | 1.1 | 23.3 | 13.2 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.9 | | 1.4 | 0.1 | 4.8 | 2.8 |
| Delay (s) | 16.4 | | 7.2 | 1.2 | 28.1 | 16.0 |
| Level of Service | B | | A | A | C | B |
| Approach Delay (s) | 16.4 | | | 4.4 | 16.2 | |
| Approach LOS | B | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 10.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.79 | | |
| Actuated Cycle Length (s) | 48.3 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 65.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 485 | 10 | 445 | 400 | 10 | 525 |
| Future Volume (veh/h) | 485 | 10 | 445 | 400 | 10 | 525 |
| Number | 2 | 12 | 1 | 6 | 3 | 18 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1900 | 1863 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 527 | 11 | 484 | 435 | 11 | 571 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 627 | 13 | 545 | 1143 | 457 | 731 |
| Arrive On Green | 0.34 | 0.34 | 0.20 | 0.61 | 0.26 | 0.26 |
| Sat Flow, veh/h | 1818 | 38 | 1774 | 1863 | 1774 | 1583 |
| Grp Volume(v), veh/h | 0 | 538 | 484 | 435 | 11 | 571 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1856 | 1774 | 1863 | 1774 | 1583 |
| Q Serve(g_s), s | 0.0 | 16.6 | 9.8 | 7.3 | 0.3 | 16.0 |
| Cycle Q Clear(g_c), s | 0.0 | 16.6 | 9.8 | 7.3 | 0.3 | 16.0 |
| Prop In Lane | | 0.02 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 640 | 545 | 1143 | 457 | 731 |
| V/C Ratio(X) | 0.00 | 0.84 | 0.89 | 0.38 | 0.02 | 0.78 |
| Avail Cap(c_a), veh/h | 0 | 717 | 697 | 1380 | 457 | 731 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 0.0 | 18.8 | 11.6 | 6.1 | 17.2 | 14.1 |
| Incr Delay (d2), s/veh | 0.0 | 8.1 | 11.2 | 0.2 | 0.0 | 5.5 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 9.8 | 6.3 | 3.8 | 0.1 | 9.3 |
| LnGrp Delay(d),s/veh | 0.0 | 26.8 | 22.7 | 6.3 | 17.2 | 19.5 |
| LnGrp LOS | | C | C | A | B | B |
| Approach Vol, veh/h | 538 | | | 919 | 582 | |
| Approach Delay, s/veh | 26.8 | | | 14.9 | 19.5 | |
| Approach LOS | C | | | B | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | | | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 16.7 | 25.4 | | | | 42.1 | | 20.0 |
| Change Period (Y+Rc), s | 4.0 | 4.0 | | | | 4.0 | | 4.0 |
| Max Green Setting (Gmax), s | 18.0 | 24.0 | | | | 46.0 | | 16.0 |
| Max Q Clear Time (g_c+I1), s | 11.8 | 18.6 | | | | 9.3 | | 18.0 |
| Green Ext Time (p_c), s | 0.9 | 2.8 | | | | 7.7 | | 0.0 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 19.4 |
| HCM 2010 LOS | B |

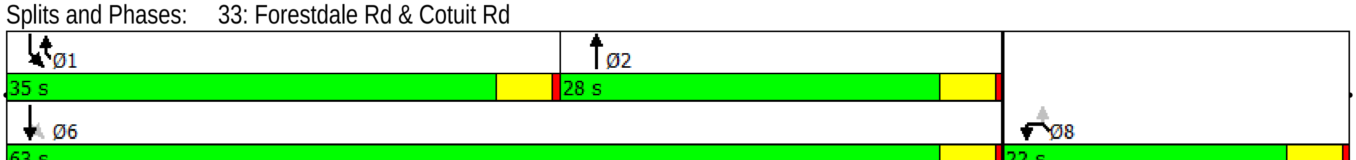
| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 480 | 10 | 620 | 495 | 5 | 385 |
| Future Volume (vph) | 480 | 10 | 620 | 495 | 5 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.214 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 399 | 1863 | 1770 | 1583 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 1 | | | | | 94 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 522 | 11 | 674 | 538 | 5 | 418 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 533 | 0 | 674 | 538 | 5 | 418 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Detector Phase | 2 | | 1 | 6 | 8 | 1 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 20.0 | 8.0 |
| Total Split (s) | 28.0 | | 35.0 | 63.0 | 22.0 | 35.0 |
| Total Split (%) | 32.9% | | 41.2% | 74.1% | 25.9% | 41.2% |
| Maximum Green (s) | 24.0 | | 31.0 | 59.0 | 18.0 | 31.0 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | Lag | | Lead | | | Lead |
| Lead-Lag Optimize? | Yes | | Yes | | | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | None | None |
| Walk Time (s) | 5.0 | | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | | | 0 | 0 | |
| Act Effct Green (s) | 24.6 | | 52.4 | 55.8 | 5.9 | 25.3 |
| Actuated g/C Ratio | 0.42 | | 0.90 | 0.96 | 0.10 | 0.44 |
| v/c Ratio | 0.68 | | 0.73 | 0.30 | 0.03 | 0.56 |
| Control Delay | 22.6 | | 12.2 | 1.1 | 28.6 | 11.7 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 22.6 | | 12.2 | 1.1 | 28.6 | 11.7 |
| LOS | C | | B | A | C | B |
| Approach Delay | 22.6 | | | 7.3 | 11.9 | |
| Approach LOS | C | | | A | B | |
| Queue Length 50th (ft) | 141 | | 72 | 0 | 2 | 74 |
| Queue Length 95th (ft) | #403 | | 285 | 70 | 12 | 136 |
| Internal Link Dist (ft) | 1369 | | | 820 | 296 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 785 | | 1108 | 1779 | 561 | 949 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.68 | | 0.61 | 0.30 | 0.01 | 0.44 |

Intersection Summary

Area Type: Other
Cycle Length: 85
Actuated Cycle Length: 58.1
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 11.9 Intersection LOS: B
Intersection Capacity Utilization 73.6% ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 33: Forestdale Rd & Cotuit Rd



| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 480 | 10 | 620 | 495 | 5 | 385 |
| Future Volume (vph) | 480 | 10 | 620 | 495 | 5 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1858 | | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.21 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1858 | | 399 | 1863 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 522 | 11 | 674 | 538 | 5 | 418 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 56 |
| Lane Group Flow (vph) | 532 | 0 | 674 | 538 | 5 | 362 |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Actuated Green, G (s) | 24.6 | | 52.3 | 52.3 | 1.0 | 24.7 |
| Effective Green, g (s) | 24.6 | | 52.3 | 52.3 | 1.0 | 24.7 |
| Actuated g/C Ratio | 0.40 | | 0.85 | 0.85 | 0.02 | 0.40 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 745 | | 870 | 1589 | 28 | 741 |
| v/s Ratio Prot | 0.29 | | c0.30 | 0.29 | 0.00 | c0.19 |
| v/s Ratio Perm | | | c0.36 | | | 0.04 |
| v/c Ratio | 0.71 | | 0.77 | 0.34 | 0.18 | 0.49 |
| Uniform Delay, d1 | 15.4 | | 9.4 | 0.9 | 29.7 | 13.6 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.3 | | 4.4 | 0.1 | 3.0 | 0.5 |
| Delay (s) | 18.7 | | 13.7 | 1.1 | 32.8 | 14.1 |
| Level of Service | B | | B | A | C | B |
| Approach Delay (s) | 18.7 | | | 8.1 | 14.3 | |
| Approach LOS | B | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.83 | | |
| Actuated Cycle Length (s) | 61.3 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 73.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 480 | 10 | 620 | 495 | 5 | 385 |
| Future Volume (veh/h) | 480 | 10 | 620 | 495 | 5 | 385 |
| Number | 2 | 12 | 1 | 6 | 3 | 18 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1900 | 1863 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 522 | 11 | 674 | 538 | 5 | 418 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 558 | 12 | 722 | 1303 | 351 | 853 |
| Arrive On Green | 0.31 | 0.31 | 0.34 | 0.70 | 0.20 | 0.20 |
| Sat Flow, veh/h | 1818 | 38 | 1774 | 1863 | 1774 | 1583 |
| Grp Volume(v), veh/h | 0 | 533 | 674 | 538 | 5 | 418 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1856 | 1774 | 1863 | 1774 | 1583 |
| Q Serve(g_s), s | 0.0 | 21.7 | 23.2 | 9.5 | 0.2 | 12.9 |
| Cycle Q Clear(g_c), s | 0.0 | 21.7 | 23.2 | 9.5 | 0.2 | 12.9 |
| Prop In Lane | | 0.02 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 570 | 722 | 1303 | 351 | 853 |
| V/C Ratio(X) | 0.00 | 0.93 | 0.93 | 0.41 | 0.01 | 0.49 |
| Avail Cap(c_a), veh/h | 0 | 572 | 823 | 1412 | 410 | 906 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 0.0 | 26.2 | 18.1 | 4.9 | 25.1 | 11.3 |
| Incr Delay (d2), s/veh | 0.0 | 22.8 | 16.3 | 0.2 | 0.0 | 0.4 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 14.7 | 17.1 | 4.9 | 0.1 | 5.7 |
| LnGrp Delay(d),s/veh | 0.0 | 49.0 | 34.4 | 5.2 | 25.1 | 11.7 |
| LnGrp LOS | | D | C | A | C | B |
| Approach Vol, veh/h | 533 | | | 1212 | 423 | |
| Approach Delay, s/veh | 49.0 | | | 21.4 | 11.9 | |
| Approach LOS | D | | | C | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | | | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 30.5 | 27.9 | | | | 58.4 | | 19.4 |
| Change Period (Y+Rc), s | 4.0 | 4.0 | | | | 4.0 | | 4.0 |
| Max Green Setting (Gmax), s | 31.0 | 24.0 | | | | 59.0 | | 18.0 |
| Max Q Clear Time (g_c+I1), s | 25.2 | 23.7 | | | | 11.5 | | 14.9 |
| Green Ext Time (p_c), s | 1.4 | 0.2 | | | | 9.1 | | 0.5 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 26.3 |
| HCM 2010 LOS | C |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.207 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 386 | 1863 | 1770 | 1583 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 2 | | | | | 144 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 11 | 478 | 418 | 11 | 571 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 560 | 0 | 478 | 418 | 11 | 571 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Detector Phase | 2 | | 1 | 6 | 8 | 1 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 20.0 | 8.0 |
| Total Split (s) | 29.0 | | 21.0 | 50.0 | 20.0 | 21.0 |
| Total Split (%) | 41.4% | | 30.0% | 71.4% | 28.6% | 30.0% |
| Maximum Green (s) | 25.0 | | 17.0 | 46.0 | 16.0 | 17.0 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | Lag | | Lead | | | Lead |
| Lead-Lag Optimize? | Yes | | Yes | | | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | None | None |
| Walk Time (s) | 5.0 | | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | | | 0 | 0 | |
| Act Effct Green (s) | 19.6 | | 39.7 | 43.3 | 6.1 | 17.5 |
| Actuated g/C Ratio | 0.43 | | 0.87 | 0.95 | 0.13 | 0.38 |
| v/c Ratio | 0.70 | | 0.58 | 0.24 | 0.05 | 0.82 |
| Control Delay | 17.3 | | 8.4 | 1.1 | 22.1 | 21.4 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 17.3 | | 8.4 | 1.1 | 22.1 | 21.4 |
| LOS | B | | A | A | C | C |
| Approach Delay | 17.3 | | | 5.0 | 21.4 | |
| Approach LOS | B | | | A | C | |
| Queue Length 50th (ft) | 106 | | 15 | 0 | 3 | 93 |
| Queue Length 95th (ft) | #281 | | #165 | 56 | 16 | 228 |
| Internal Link Dist (ft) | 1369 | | | 820 | 296 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 1074 | | 880 | 1751 | 654 | 760 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.52 | | 0.54 | 0.24 | 0.02 | 0.75 |

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 45.5
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.82
Intersection Signal Delay: 13.1 Intersection LOS: B
Intersection Capacity Utilization 66.4% ICU Level of Service C
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 33: Forestdale Rd & Cotuit Rd

# HCM Signalized Intersection Capacity Analysis
## 33: Forestdale Rd & Cotuit Rd

02/13/2018

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1858 | | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.21 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1858 | | 386 | 1863 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 11 | 478 | 418 | 11 | 571 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 94 |
| Lane Group Flow (vph) | 559 | 0 | 478 | 418 | 11 | 477 |
| Turn Type | NA | | pm+pt | NA | Prot | pm+ov |
| Protected Phases | 2 | | 1 | 6 | 8 | 1 |
| Permitted Phases | | | 6 | | | 8 |
| Actuated Green, G (s) | 19.9 | | 39.7 | 39.7 | 1.0 | 16.8 |
| Effective Green, g (s) | 19.9 | | 39.7 | 39.7 | 1.0 | 16.8 |
| Actuated g/C Ratio | 0.41 | | 0.82 | 0.82 | 0.02 | 0.34 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 759 | | 763 | 1518 | 36 | 676 |
| v/s Ratio Prot | c0.30 | | 0.20 | 0.22 | 0.01 | c0.23 |
| v/s Ratio Perm | | | 0.31 | | | 0.07 |
| v/c Ratio | 0.74 | | 0.63 | 0.28 | 0.31 | 0.71 |
| Uniform Delay, d1 | 12.2 | | 6.1 | 1.1 | 23.5 | 13.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.7 | | 1.6 | 0.1 | 4.8 | 3.4 |
| Delay (s) | 15.9 | | 7.7 | 1.2 | 28.3 | 17.2 |
| Level of Service | B | | A | A | C | B |
| Approach Delay (s) | 15.9 | | | 4.7 | 17.4 | |
| Approach LOS | B | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 48.7 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 66.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Volume (veh/h) | 505 | 10 | 440 | 385 | 10 | 525 |
| Number | 2 | 12 | 1 | 6 | 3 | 18 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1900 | 1863 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 549 | 11 | 478 | 418 | 11 | 571 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 647 | 13 | 535 | 1154 | 450 | 720 |
| Arrive On Green | 0.36 | 0.36 | 0.20 | 0.62 | 0.25 | 0.25 |
| Sat Flow, veh/h | 1820 | 36 | 1774 | 1863 | 1774 | 1583 |
| Grp Volume(v), veh/h | 0 | 560 | 478 | 418 | 11 | 571 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1856 | 1774 | 1863 | 1774 | 1583 |
| Q Serve(g_s), s | 0.0 | 17.6 | 9.9 | 6.9 | 0.3 | 16.0 |
| Cycle Q Clear(g_c), s | 0.0 | 17.6 | 9.9 | 6.9 | 0.3 | 16.0 |
| Prop In Lane | | 0.02 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 660 | 535 | 1154 | 450 | 720 |
| V/C Ratio(X) | 0.00 | 0.85 | 0.89 | 0.36 | 0.02 | 0.79 |
| Avail Cap(c_a), veh/h | 0 | 736 | 657 | 1358 | 450 | 720 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 0.0 | 18.8 | 12.2 | 5.9 | 17.7 | 14.7 |
| Incr Delay (d2), s/veh | 0.0 | 8.5 | 12.7 | 0.2 | 0.0 | 6.1 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 10.4 | 9.9 | 3.5 | 0.1 | 9.5 |
| LnGrp Delay(d),s/veh | 0.0 | 27.3 | 24.9 | 6.1 | 17.7 | 20.8 |
| LnGrp LOS | | C | C | A | B | C |
| Approach Vol, veh/h | 560 | | | 896 | 582 | |
| Approach Delay, s/veh | 27.3 | | | 16.1 | 20.7 | |
| Approach LOS | C | | | B | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | | | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 16.7 | 26.4 | | | | 43.1 | | 20.0 |
| Change Period (Y+Rc), s | 4.0 | 4.0 | | | | 4.0 | | 4.0 |
| Max Green Setting (Gmax), s | 17.0 | 25.0 | | | | 46.0 | | 16.0 |
| Max Q Clear Time (g_c+I1), s | 11.9 | 19.6 | | | | 8.9 | | 18.0 |
| Green Ext Time (p_c), s | 0.8 | 2.8 | | | | 7.7 | | 0.0 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 20.5 |
| HCM 2010 LOS | | C |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 460 | 10 | 620 | 495 | 5 | 385 |
| Future Volume (vph) | 460 | 10 | 620 | 495 | 5 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 500 | 11 | 674 | 538 | 5 | 418 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 511 | 0 | 674 | 538 | 5 | 418 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 72.5% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 460 | 10 | 620 | 495 | 5 | 385 |
| Future Volume (Veh/h) | 460 | 10 | 620 | 495 | 5 | 385 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 500 | 11 | 674 | 538 | 5 | 418 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 511 | | 2392 | 506 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 511 | | 2392 | 506 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 36 | | 63 | 26 |
| cM capacity (veh/h) | | | 1054 | | 13 | 567 |

| Direction, Lane # | NB 1 | SB 1 | SB 2 | NW 1 | NW 2 |
|---|---|---|---|---|---|
| Volume Total | 511 | 674 | 538 | 5 | 418 |
| Volume Left | 0 | 674 | 0 | 5 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 418 |
| cSH | 1700 | 1054 | 1700 | 13 | 567 |
| Volume to Capacity | 0.30 | 0.64 | 0.32 | 0.37 | 0.74 |
| Queue Length 95th (ft) | 0 | 121 | 0 | 24 | 157 |
| Control Delay (s) | 0.0 | 14.3 | 0.0 | 386.9 | 27.1 |
| Lane LOS | | B | | F | D |
| Approach Delay (s) | 0.0 | 7.9 | | 31.4 | |
| Approach LOS | | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 10.7 | | |
| Intersection Capacity Utilization | 72.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 10.8 |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 460 | 10 | 620 | 495 | 5 | 385 |
| Future Vol, veh/h | 460 | 10 | 620 | 495 | 5 | 385 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 0 | - | 0 | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 500 | 11 | 674 | 538 | 5 | 418 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 511 | 0 | 2391 | 505 |
| Stage 1 | - | - | - | - | 505 | - |
| Stage 2 | - | - | - | - | 1886 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.42 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.42 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.42 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.518 | 3.318 |
| Pot Cap-1 Maneuver | - | - | 1054 | - | 37 | 567 |
| Stage 1 | - | - | - | - | 606 | - |
| Stage 2 | - | - | - | - | 131 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1054 | - | 13 | 567 |
| Mov Cap-2 Maneuver | - | - | - | - | 13 | - |
| Stage 1 | - | - | - | - | 606 | - |
| Stage 2 | - | - | - | - | 47 | - |

| Approach | NB | SB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 7.9 | 32.1 |
| HCM LOS | | | D |

| Minor Lane/Major Mvmt | NBT | NBR | NWLn1 | NWLn2 | SBL | SBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | 13 | 567 | 1054 | - |
| HCM Lane V/C Ratio | - | - | 0.418 | 0.738 | 0.639 | - |
| HCM Control Delay (s) | - | - | $ 414.1 | 27.1 | 14.3 | - |
| HCM Lane LOS | - | - | F | D | B | - |
| HCM 95th %tile Q(veh) | - | - | 1 | 6.3 | 4.8 | - |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Volume (vph) | 505 | 10 | 440 | 385 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.997 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1857 | 0 | 1770 | 1863 | 1770 | 1583 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 11 | 478 | 418 | 11 | 571 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 560 | 0 | 478 | 418 | 11 | 571 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 66.4% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Volume (Veh/h) | 505 | 10 | 440 | 385 | 10 | 525 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 549 | 11 | 478 | 418 | 11 | 571 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 560 | | 1928 | 554 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 560 | | 1928 | 554 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 53 | | 71 | 0 |
| cM capacity (veh/h) | | | 1011 | | 38 | 532 |

| Direction, Lane # | NB 1 | SB 1 | SB 2 | NW 1 | NW 2 |
|---|---|---|---|---|---|
| Volume Total | 560 | 478 | 418 | 11 | 571 |
| Volume Left | 0 | 478 | 0 | 11 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 571 |
| cSH | 1700 | 1011 | 1700 | 38 | 532 |
| Volume to Capacity | 0.33 | 0.47 | 0.25 | 0.29 | 1.07 |
| Queue Length 95th (ft) | 0 | 65 | 0 | 24 | 432 |
| Control Delay (s) | 0.0 | 11.7 | 0.0 | 132.5 | 88.0 |
| Lane LOS | | B | | F | F |
| Approach Delay (s) | 0.0 | 6.2 | | 88.9 | |
| Approach LOS | | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 28.1 | | |
| Intersection Capacity Utilization | 66.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 28 |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 505 | 10 | 440 | 385 | 10 | 525 |
| Future Vol, veh/h | 505 | 10 | 440 | 385 | 10 | 525 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 0 | - | 0 | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 549 | 11 | 478 | 418 | 11 | 571 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 560 | 0 | 1929 | 554 |
| Stage 1 | - | - | - | - | 554 | - |
| Stage 2 | - | - | - | - | 1375 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.42 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.42 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.42 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.518 | 3.318 |
| Pot Cap-1 Maneuver | - | - | 1011 | - | 73 | ~ 532 |
| Stage 1 | - | - | - | - | 575 | - |
| Stage 2 | - | - | - | - | 235 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1011 | - | 38 | ~ 532 |
| Mov Cap-2 Maneuver | - | - | - | - | 38 | - |
| Stage 1 | - | - | - | - | 575 | - |
| Stage 2 | - | - | - | - | 124 | - |

| Approach | NB | SB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 6.2 | 88.5 |
| HCM LOS | | | F |

| Minor Lane/Major Mvmt | NBT | NBR | NWLn1 | NWLn2 | SBL | SBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | 38 | 532 | 1011 | - |
| HCM Lane V/C Ratio | - | - | 0.286 | 1.073 | 0.473 | - |
| HCM Control Delay (s) | - | - | 134 | 87.6 | 11.7 | - |
| HCM Lane LOS | - | - | F | F | B | - |
| HCM 95th %tile Q(veh) | - | - | 0.9 | 17.2 | 2.6 | - |

Notes

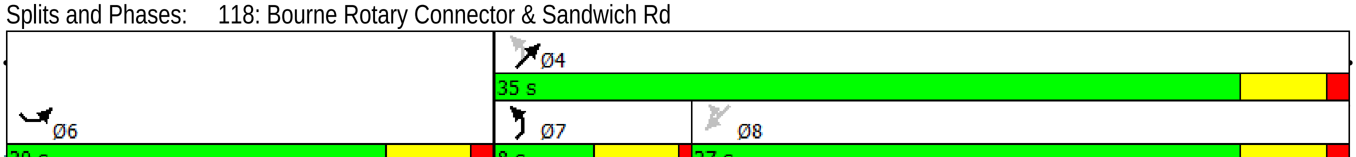
~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Future Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.896 | | | | | 0.850 |
| Flt Protected | 0.985 | | | 0.999 | | |
| Satd. Flow (prot) | 3098 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.985 | | | 0.950 | | |
| Satd. Flow (perm) | 3098 | 0 | 0 | 3266 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 353 | | | | | 603 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 158 | 353 | 11 | 984 | 457 | 603 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 511 | 0 | 0 | 995 | 457 | 603 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 35.0 | 27.0 | 27.0 |
| Total Split (%) | 36.4% | | 14.5% | 63.6% | 49.1% | 49.1% |
| Maximum Green (s) | 15.5 | | 4.0 | 30.5 | 22.5 | 22.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.2 | | | 19.2 | 19.2 | 19.2 |
| Actuated g/C Ratio | 0.22 | | | 0.52 | 0.52 | 0.52 |
| v/c Ratio | 0.53 | | | 0.59 | 0.49 | 0.55 |
| Control Delay | 7.1 | | | 7.7 | 7.8 | 2.8 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 7.1 | | | 7.7 | 7.8 | 2.8 |
| LOS | A | | | A | A | A |
| Approach Delay | 7.1 | | | 7.7 | 4.9 | |
| Approach LOS | A | | | A | A | |
| Queue Length 50th (ft) | 12 | | | 55 | 45 | 0 |
| Queue Length 95th (ft) | 52 | | | 126 | 122 | 32 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1577 | | | 2749 | 1227 | 1236 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.32 | | | 0.36 | 0.37 | 0.49 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 55 | |
| Actuated Cycle Length: 36.9 | |
| Natural Cycle: 55 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.59 | |
| Intersection Signal Delay: 6.5 | Intersection LOS: A |
| Intersection Capacity Utilization 67.2% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Future Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.90 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.98 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3099 | | | 3436 | 1810 | 1538 |
| Flt Permitted | 0.98 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3099 | | | 3265 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 158 | 353 | 11 | 984 | 457 | 603 |
| RTOR Reduction (vph) | 273 | 0 | 0 | 0 | 0 | 286 |
| Lane Group Flow (vph) | 238 | 0 | 0 | 995 | 457 | 317 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.2 | | | 19.1 | 19.1 | 19.1 |
| Effective Green, g (s) | 8.2 | | | 19.1 | 19.1 | 19.1 |
| Actuated g/C Ratio | 0.23 | | | 0.53 | 0.53 | 0.53 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 700 | | | 1717 | 952 | 809 |
| v/s Ratio Prot | c0.08 | | | | | |
| v/s Ratio Perm | | | | c0.30 | 0.25 | 0.21 |
| v/c Ratio | 0.34 | | | 0.58 | 0.48 | 0.39 |
| Uniform Delay, d1 | 11.8 | | | 5.9 | 5.5 | 5.1 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | | | 0.5 | 0.4 | 0.3 |
| Delay (s) | 12.1 | | | 6.3 | 5.8 | 5.4 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 12.1 | | | 6.3 | 5.6 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.2 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 36.3 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 67.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 970 | 670 | 215 | 130 | 270 |
| Future Volume (vph) | 0 | 970 | 670 | 215 | 130 | 270 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.967 | | | 0.850 |
| Flt Protected | | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1810 | 1750 | 0 | 1719 | 1538 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1810 | 1750 | 0 | 1719 | 1538 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 1054 | 728 | 234 | 141 | 293 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1054 | 962 | 0 | 141 | 293 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 71.7% ICU Level of Service C

Analysis Period (min) 15

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 970 | 670 | 215 | 130 | 270 |
| Future Volume (Veh/h) | 0 | 970 | 670 | 215 | 130 | 270 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 1054 | 728 | 234 | 141 | 293 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 728 | | | | 1899 | 845 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 728 | | | | 1899 | 845 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 0 | 18 |
| cM capacity (veh/h) | 862 | | | | 75 | 358 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 1054 | 962 | 141 | 293 |
| Volume Left | 0 | 0 | 141 | 0 |
| Volume Right | 0 | 234 | 0 | 293 |
| cSH | 862 | 1700 | 75 | 358 |
| Volume to Capacity | 0.00 | 0.57 | 1.89 | 0.82 |
| Queue Length 95th (ft) | 0 | 0 | 313 | 179 |
| Control Delay (s) | 0.0 | 0.0 | 536.6 | 47.4 |
| Lane LOS | | | F | E |
| Approach Delay (s) | 0.0 | 0.0 | 206.3 | |
| Approach LOS | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 36.6 | | |
| Intersection Capacity Utilization | 71.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 29.8 | | | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 0 | 970 | 670 | 215 | 130 | 270 |
| Future Vol, veh/h | 0 | 970 | 670 | 215 | 130 | 270 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 1054 | 728 | 234 | 141 | 293 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 728 | 0 | - | 0 | 1782 | 728 |
| Stage 1 | - | - | - | - | 728 | - |
| Stage 2 | - | - | - | - | 1054 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 862 | - | - | 0 | ~ 88 | 418 |
| Stage 1 | - | - | - | 0 | 473 | - |
| Stage 2 | - | - | - | 0 | 331 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 862 | - | - | - | ~ 88 | 418 |
| Mov Cap-2 Maneuver | - | - | - | - | ~ 88 | - |
| Stage 1 | - | - | - | - | 473 | - |
| Stage 2 | - | - | - | - | 331 | - |

| Approach | EB | | WB | | SB | |
|---|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | 0 | | 151.8 | |
| HCM LOS | | | | | F | |

| Minor Lane/Major Mvmt | | EBL | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | | 862 | - | - | 88 | 418 |
| HCM Lane V/C Ratio | | - | - | - | 1.606 | 0.702 |
| HCM Control Delay (s) | | 0 | - | - | $ 401.6 | 31.5 |
| HCM Lane LOS | | A | - | - | F | D |
| HCM 95th %tile Q(veh) | | 0 | - | - | 11.3 | 5.3 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Future Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.948 | | | 0.850 |
| Flt Protected | | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1810 | 1715 | 0 | 1719 | 1538 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1810 | 1715 | 0 | 1719 | 1538 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 1076 | 728 | 451 | 207 | 353 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1076 | 1179 | 0 | 207 | 353 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 87.4% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 990 | 670 | 415 | 190 | 325 |
| Future Volume (Veh/h) | 0 | 990 | 670 | 415 | 190 | 325 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 1076 | 728 | 451 | 207 | 353 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 728 | | | | 2030 | 954 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 728 | | | | 2030 | 954 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 0 | 0 |
| cM capacity (veh/h) | 862 | | | | 62 | 310 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 1076 | 1179 | 207 | 353 |
| Volume Left | 0 | 0 | 207 | 0 |
| Volume Right | 0 | 451 | 0 | 353 |
| cSH | 862 | 1700 | 62 | 310 |
| Volume to Capacity | 0.00 | 0.69 | 3.35 | 1.14 |
| Queue Length 95th (ft) | 0 | 0 | Err | 363 |
| Control Delay (s) | 0.0 | 0.0 | Err | 131.1 |
| Lane LOS | | | F | F |
| Approach Delay (s) | 0.0 | 0.0 | 3778.7 | |
| Approach LOS | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 751.7 | | |
| Intersection Capacity Utilization | 87.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 71.7 | | | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 0 | 990 | 670 | 415 | 190 | 325 |
| Future Vol, veh/h | 0 | 990 | 670 | 415 | 190 | 325 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 1076 | 728 | 451 | 207 | 353 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 728 | 0 | - | 0 | 1804 | 728 |
| Stage 1 | - | - | - | - | 728 | - |
| Stage 2 | - | - | - | - | 1076 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 862 | - | - | 0 | ~ 86 | 418 |
| Stage 1 | - | - | - | 0 | 473 | - |
| Stage 2 | - | - | - | 0 | 323 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 862 | - | - | - | ~ 86 | 418 |
| Mov Cap-2 Maneuver | - | - | - | - | ~ 86 | - |
| Stage 1 | - | - | - | - | 473 | - |
| Stage 2 | - | - | - | - | 323 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0 | $ 302.8 |
| HCM LOS | | | F |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 862 | - | - | 86 | 418 |
| HCM Lane V/C Ratio | - | - | - | 2.401 | 0.845 |
| HCM Control Delay (s) | 0 | - | - | $ 742.5 | 45.8 |
| HCM Lane LOS | A | - | - | F | E |
| HCM 95th %tile Q(veh) | 0 | - | - | 19.1 | 8.2 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

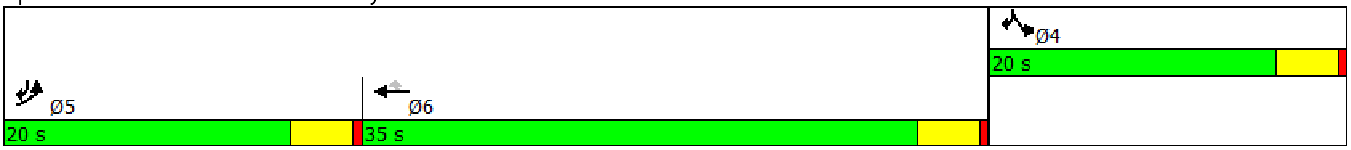
| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Future Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 200 | | | 400 | 0 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | | | | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 451 | | 114 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 1076 | 728 | 451 | 207 | 353 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1076 | 728 | 451 | 207 | 353 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 5 | | 6 | 6 | 4 | 4 5 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Minimum Split (s) | 20.0 | | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | | 35.0 | 35.0 | 20.0 | |
| Total Split (%) | 26.7% | | 46.7% | 46.7% | 26.7% | |
| Maximum Green (s) | 16.0 | | 31.0 | 31.0 | 16.0 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | -1.0 | | -1.0 | -1.0 | -1.0 | |
| Total Lost Time (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | | Min | Min | None | |
| Walk Time (s) | | | 5.0 | 5.0 | | |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | | |
| Pedestrian Calls (#/hr) | | | 15 | 15 | | |
| Act Effct Green (s) | | 60.4 | 30.6 | 30.6 | 13.5 | 23.7 |
| Actuated g/C Ratio | | 1.00 | 0.51 | 0.51 | 0.22 | 0.39 |
| v/c Ratio | | 0.59 | 0.79 | 0.45 | 0.54 | 0.52 |
| Control Delay | | 1.4 | 21.6 | 2.8 | 26.7 | 12.6 |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | | 1.4 | 21.6 | 2.8 | 26.7 | 12.6 |
| LOS | | A | C | A | C | B |
| Approach Delay | | 1.4 | 14.4 | | 17.8 | |
| Approach LOS | | A | B | | B | |
| Queue Length 50th (ft) | | 0 | 205 | 0 | 69 | 63 |
| Queue Length 95th (ft) | | 0 | #436 | 41 | 127 | 131 |
| Internal Link Dist (ft) | | 832 | 886 | | 84 | |
| Turn Bay Length (ft) | | | | 400 | | |
| Base Capacity (vph) | | 1810 | 970 | 1033 | 489 | 897 |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | | 0.59 | 0.75 | 0.44 | 0.42 | 0.39 |

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 60.4
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 10.1 Intersection LOS: B
Intersection Capacity Utilization 69.3% ICU Level of Service C
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
! Phase conflict between lane groups.

Splits and Phases: 3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Future Volume (vph) | 0 | 990 | 670 | 415 | 190 | 325 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1810 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 1076 | 728 | 451 | 207 | 353 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 222 | 0 | 69 |
| Lane Group Flow (vph) | 0 | 1076 | 728 | 229 | 207 | 284 |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |
| Actuated Green, G (s) | | 60.2 | 29.6 | 29.6 | 12.5 | 22.6 |
| Effective Green, g (s) | | 60.2 | 30.6 | 30.6 | 13.5 | 23.6 |
| Actuated g/C Ratio | | 1.00 | 0.51 | 0.51 | 0.22 | 0.39 |
| Clearance Time (s) | | | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 1810 | 920 | 781 | 385 | 602 |
| v/s Ratio Prot | | 0.59 | c0.40 | | 0.12 | 0.18 |
| v/s Ratio Perm | | | | 0.15 | | |
| v/c Ratio | | 0.59 | 0.79 | 0.29 | 0.54 | 0.47 |
| Uniform Delay, d1 | | 0.0 | 12.2 | 8.6 | 20.6 | 13.6 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 1.4 | 4.7 | 0.2 | 1.4 | 0.6 |
| Delay (s) | | 1.4 | 16.9 | 8.8 | 22.0 | 14.2 |
| Level of Service | | A | B | A | C | B |
| Approach Delay (s) | | 1.4 | 13.8 | | 17.1 | |
| Approach LOS | | A | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 9.7 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 60.2 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 69.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

! Phase conflict between lane groups.
c Critical Lane Group

HCM 2010 analysis cannot be performed with phasing conflicts.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Future Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.942 | | | | | 0.850 |
| Flt Protected | 0.970 | | | 0.999 | | |
| Satd. Flow (prot) | 3208 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.970 | | | 0.946 | | |
| Satd. Flow (perm) | 3208 | 0 | 0 | 3252 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 136 | | | | | 837 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 217 | 136 | 27 | 1250 | 293 | 837 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 353 | 0 | 0 | 1277 | 293 | 837 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

## Lanes, Volumes, Timings
## 118: Bourne Rotary Connector & Sandwich Rd

02/15/2018

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 40.0 | 32.0 | 32.0 |
| Total Split (%) | 33.3% | | 13.3% | 66.7% | 53.3% | 53.3% |
| Maximum Green (s) | 15.5 | | 4.0 | 35.5 | 27.5 | 27.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Actuated g/C Ratio | 0.20 | | | 0.59 | 0.59 | 0.59 |
| v/c Ratio | 0.47 | | | 0.67 | 0.27 | 0.67 |
| Control Delay | 13.0 | | | 8.2 | 5.3 | 3.5 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 13.0 | | | 8.2 | 5.3 | 3.5 |
| LOS | B | | | A | A | A |
| Approach Delay | 13.0 | | | 8.2 | 4.0 | |
| Approach LOS | B | | | A | A | |
| Queue Length 50th (ft) | 24 | | | 90 | 29 | 0 |
| Queue Length 95th (ft) | 63 | | | 173 | 68 | 34 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1258 | | | 2629 | 1258 | 1324 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.28 | | | 0.49 | 0.23 | 0.63 |

**Intersection Summary**

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 44.5

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

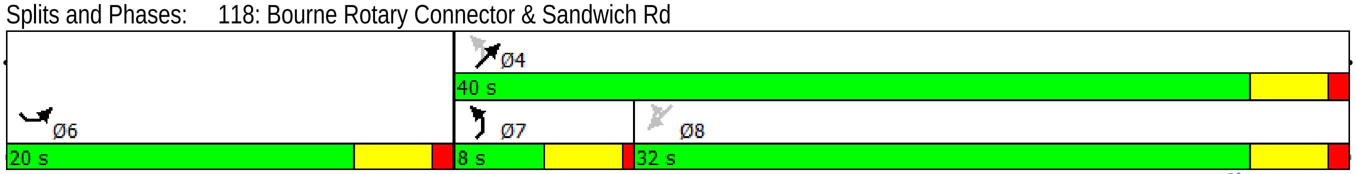
Maximum v/c Ratio: 0.67

Intersection Signal Delay: 7.1 Intersection LOS: A

Intersection Capacity Utilization 87.7% ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Future Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.94 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.97 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3209 | | | 3434 | 1810 | 1538 |
| Flt Permitted | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3209 | | | 3252 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 217 | 136 | 27 | 1250 | 293 | 837 |
| RTOR Reduction (vph) | 109 | 0 | 0 | 0 | 0 | 339 |
| Lane Group Flow (vph) | 244 | 0 | 0 | 1277 | 293 | 498 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Effective Green, g (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Actuated g/C Ratio | 0.20 | | | 0.60 | 0.60 | 0.60 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 641 | | | 1936 | 1077 | 915 |
| v/s Ratio Prot | c0.08 | | | | | |
| v/s Ratio Perm | | | | c0.39 | 0.16 | 0.32 |
| v/c Ratio | 0.38 | | | 0.66 | 0.27 | 0.54 |
| Uniform Delay, d1 | 15.2 | | | 5.9 | 4.3 | 5.3 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | | | 0.8 | 0.1 | 0.7 |
| Delay (s) | 15.6 | | | 6.8 | 4.4 | 6.0 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 15.6 | | | 6.8 | 5.6 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.4 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.67 | | |
| Actuated Cycle Length (s) | 44.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 87.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 1235 | 895 | 120 | 55 | 105 |
| Future Volume (vph) | 15 | 1235 | 895 | 120 | 55 | 105 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.984 | | | 0.850 |
| Flt Protected | | 0.999 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1808 | 1781 | 0 | 1719 | 1538 |
| Flt Permitted | | 0.999 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1808 | 1781 | 0 | 1719 | 1538 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 1342 | 973 | 130 | 60 | 114 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1358 | 1103 | 0 | 60 | 114 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 87.0% ICU Level of Service E

Analysis Period (min) 15

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 15 | 1235 | 895 | 120 | 55 | 105 |
| Future Volume (Veh/h) | 15 | 1235 | 895 | 120 | 55 | 105 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 16 | 1342 | 973 | 130 | 60 | 114 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 973 | | | | 2412 | 1038 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 973 | | | | 2412 | 1038 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 98 | | | | 0 | 59 |
| cM capacity (veh/h) | 697 | | | | 35 | 277 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 1358 | 1103 | 60 | 114 |
| Volume Left | 16 | 0 | 60 | 0 |
| Volume Right | 0 | 130 | 0 | 114 |
| cSH | 697 | 1700 | 35 | 277 |
| Volume to Capacity | 0.02 | 0.65 | 1.74 | 0.41 |
| Queue Length 95th (ft) | 2 | 0 | 165 | 48 |
| Control Delay (s) | 1.2 | 0.0 | 606.2 | 26.8 |
| Lane LOS | A | | F | D |
| Approach Delay (s) | 1.2 | 0.0 | 226.6 | |
| Approach LOS | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 15.6 | | |
| Intersection Capacity Utilization | 87.0% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 15.2 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 15 | 1235 | 895 | 120 | 55 | 105 |
| Future Vol, veh/h | 15 | 1235 | 895 | 120 | 55 | 105 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 16 | 1342 | 973 | 130 | 60 | 114 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 973 | 0 | - | 0 | 2348 | 973 |
| Stage 1 | - | - | - | - | 973 | - |
| Stage 2 | - | - | - | - | 1375 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 697 | - | - | 0 | ~ 39 | 302 |
| Stage 1 | - | - | - | 0 | 362 | - |
| Stage 2 | - | - | - | 0 | 231 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 697 | - | - | - | ~ 35 | 302 |
| Mov Cap-2 Maneuver | - | - | - | - | ~ 35 | - |
| Stage 1 | - | - | - | - | 362 | - |
| Stage 2 | - | - | - | - | 210 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 218.7 |
| HCM LOS | | | F |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 697 | - | - | 35 | 302 |
| HCM Lane V/C Ratio | 0.023 | - | - | 1.708 | 0.378 |
| HCM Control Delay (s) | 10.3 | 0 | - | $ 590.3 | 24 |
| HCM Lane LOS | B | A | - | F | C |
| HCM 95th %tile Q(veh) | 0.1 | - | - | 6.5 | 1.7 |

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Future Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.979 | | | 0.850 |
| Flt Protected | | 0.999 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1808 | 1772 | 0 | 1719 | 1538 |
| Flt Permitted | | 0.999 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1808 | 1772 | 0 | 1719 | 1538 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 1250 | 967 | 179 | 234 | 136 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1272 | 1146 | 0 | 234 | 136 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 95.1% | ICU Level of Service F |
| Analysis Period (min) 15 | |

# HCM Unsignalized Intersection Capacity Analysis
## 2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road

02/15/2018

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Future Volume (Veh/h) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 22 | 1250 | 967 | 179 | 234 | 136 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 967 | | | | 2350 | 1056 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 967 | | | | 2350 | 1056 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 97 | | | | 0 | 50 |
| cM capacity (veh/h) | 700 | | | | 37 | 270 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 1272 | 1146 | 234 | 136 |
| Volume Left | 22 | 0 | 234 | 0 |
| Volume Right | 0 | 179 | 0 | 136 |
| cSH | 700 | 1700 | 37 | 270 |
| Volume to Capacity | 0.03 | 0.67 | 6.25 | 0.50 |
| Queue Length 95th (ft) | 2 | 0 | Err | 66 |
| Control Delay (s) | 1.4 | 0.0 | Err | 31.2 |
| Lane LOS | A | | F | D |
| Approach Delay (s) | 1.4 | 0.0 | 6335.1 | |
| Approach LOS | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 841.4 | | |
| Intersection Capacity Utilization | 95.1% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 220.9 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 20 | 1150 | 890 | 165 | 215 | 125 |
| Future Vol, veh/h | 20 | 1150 | 890 | 165 | 215 | 125 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 22 | 1250 | 967 | 179 | 234 | 136 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 967 | 0 | - | 0 | 2260 | 967 |
| Stage 1 | - | - | - | - | 967 | - |
| Stage 2 | - | - | - | - | 1293 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 700 | - | - | 0 | ~ 44 | 304 |
| Stage 1 | - | - | - | 0 | 364 | - |
| Stage 2 | - | - | - | 0 | 254 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 700 | - | - | - | ~ 39 | 304 |
| Mov Cap-2 Maneuver | - | - | - | - | ~ 39 | - |
| Stage 1 | - | - | - | - | 364 | - |
| Stage 2 | - | - | - | - | ~ 228 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0.2 | 0 | $ 1558.6 |
| HCM LOS | | | F |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 700 | - | - | 39 | 304 |
| HCM Lane V/C Ratio | 0.031 | - | - | 5.992 | 0.447 |
| HCM Control Delay (s) | 10.3 | 0 | $ | 2449.6 | 26.1 |
| HCM Lane LOS | B | A | - | F | D |
| HCM 95th %tile Q(veh) | 0.1 | - | - | 27.5 | 2.2 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

Lanes, Volumes, Timings
2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road 02/15/2018

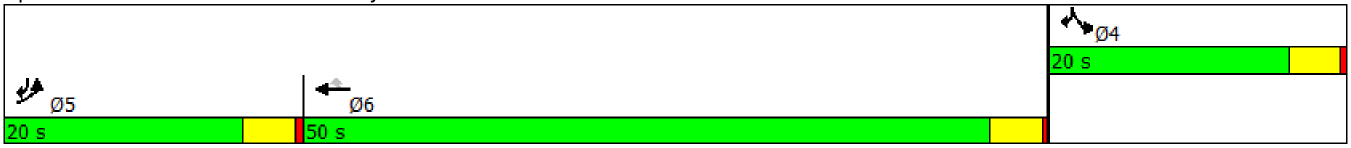
| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Future Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 200 | | | 400 | 0 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.950 | | | | 0.950 | |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 179 | | 93 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 1250 | 967 | 179 | 234 | 136 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 22 | 1250 | 967 | 179 | 234 | 136 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 5 | | 6 | 6 | 4 | 4 5 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Minimum Split (s) | 20.0 | | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | | 50.0 | 50.0 | 20.0 | |
| Total Split (%) | 22.2% | | 55.6% | 55.6% | 22.2% | |
| Maximum Green (s) | 16.0 | | 46.0 | 46.0 | 16.0 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | -1.0 | | -1.0 | -1.0 | -1.0 | |
| Total Lost Time (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | | Min | Min | None | |
| Walk Time (s) | | | 5.0 | 5.0 | | |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | | |
| Pedestrian Calls (#/hr) | | | 15 | 15 | | |
| Act Effct Green (s) | 7.6 | 79.0 | 47.0 | 47.0 | 15.4 | 25.9 |
| Actuated g/C Ratio | 0.10 | 1.00 | 0.59 | 0.59 | 0.19 | 0.33 |
| v/c Ratio | 0.13 | 0.69 | 0.90 | 0.18 | 0.70 | 0.24 |
| Control Delay | 35.2 | 2.2 | 28.1 | 1.9 | 42.1 | 8.4 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 35.2 | 2.2 | 28.1 | 1.9 | 42.1 | 8.4 |
| LOS | D | A | C | A | D | A |
| Approach Delay | | 2.8 | 24.0 | | 29.7 | |
| Approach LOS | | A | C | | C | |
| Queue Length 50th (ft) | 10 | 0 | 396 | 0 | 108 | 14 |
| Queue Length 95th (ft) | 32 | 0 | #715 | 25 | #192 | 52 |
| Internal Link Dist (ft) | | 832 | 886 | | 84 | |
| Turn Bay Length (ft) | 200 | | | 400 | | |
| Base Capacity (vph) | 370 | 1810 | 1077 | 988 | 370 | 737 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.06 | 0.69 | 0.90 | 0.18 | 0.63 | 0.18 |

**Intersection Summary**

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 79
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.90
Intersection Signal Delay: 15.1 Intersection LOS: B
Intersection Capacity Utilization 79.1% ICU Level of Service D
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
! Phase conflict between lane groups.

Splits and Phases: 2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Future Volume (vph) | 20 | 1150 | 890 | 165 | 215 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 1250 | 967 | 179 | 234 | 136 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 72 | 0 | 62 |
| Lane Group Flow (vph) | 22 | 1250 | 967 | 107 | 234 | 74 |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |
| Actuated Green, G (s) | 6.6 | 79.1 | 46.1 | 46.1 | 14.4 | 25.0 |
| Effective Green, g (s) | 7.6 | 79.1 | 47.1 | 47.1 | 15.4 | 26.0 |
| Actuated g/C Ratio | 0.10 | 1.00 | 0.60 | 0.60 | 0.19 | 0.33 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 165 | 1810 | 1077 | 915 | 334 | 505 |
| v/s Ratio Prot | 0.01 | 0.69 | c0.53 | | 0.14 | 0.05 |
| v/s Ratio Perm | | | | 0.07 | | |
| v/c Ratio | 0.13 | 0.69 | 0.90 | 0.12 | 0.70 | 0.15 |
| Uniform Delay, d1 | 32.7 | 0.0 | 13.9 | 7.0 | 29.7 | 18.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | 2.2 | 10.0 | 0.1 | 6.5 | 0.1 |
| Delay (s) | 33.1 | 2.2 | 23.9 | 7.0 | 36.2 | 18.9 |
| Level of Service | C | A | C | A | D | B |
| Approach Delay (s) | | 2.7 | 21.2 | | 29.8 | |
| Approach LOS | | A | C | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 79.1 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 79.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

! Phase conflict between lane groups.
c Critical Lane Group

HCM 2010 analysis cannot be performed with phasing conflicts.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Future Volume (vph) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 250 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 0 | | 0 | 1 | | 0 | 0 | | 1 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.998 | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | 0.950 | | | | 0.976 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 1719 | 1806 | 0 | 0 | 1766 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | 0.950 | | | | 0.976 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 1719 | 1806 | 0 | 0 | 1766 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 538 | 0 | 228 | 391 | 0 | 0 | 10 | 60 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 59.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

## HCM Unsignalized Intersection Capacity Analysis
## 54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A

02/05/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 391 | | | 538 | | | 1382 | 1382 | 536 | 1382 | 1382 | 388 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 391 | | | 538 | | | 1382 | 1382 | 536 | 1382 | 1382 | 388 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 78 | | | 95 | 95 | 89 | 100 | 100 | 99 |
| cM capacity (veh/h) | 1151 | | | 1015 | | | 98 | 110 | 539 | 85 | 110 | 653 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|---|
| Volume Total | 538 | 228 | 391 | 10 | 60 | 5 |
| Volume Left | 0 | 228 | 0 | 5 | 0 | 0 |
| Volume Right | 5 | 0 | 5 | 0 | 60 | 5 |
| cSH | 1151 | 1015 | 1700 | 104 | 539 | 653 |
| Volume to Capacity | 0.00 | 0.22 | 0.23 | 0.10 | 0.11 | 0.01 |
| Queue Length 95th (ft) | 0 | 22 | 0 | 8 | 9 | 1 |
| Control Delay (s) | 0.0 | 9.6 | 0.0 | 43.4 | 12.5 | 10.6 |
| Lane LOS | | A | | E | B | B |
| Approach Delay (s) | 0.0 | 3.5 | | 16.9 | | 10.6 |
| Approach LOS | | | | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.8 | | |
| Intersection Capacity Utilization | 59.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Future Vol, veh/h | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | 250 | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 391 | 0 | 0 | 538 | 0 | 0 | 1383 | 1383 | 535 | 1383 | 1383 | 389 |
| Stage 1 | - | - | - | - | - | - | 535 | 535 | - | 845 | 845 | - |
| Stage 2 | - | - | - | - | - | - | 848 | 848 | - | 538 | 538 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 1151 | - | - | 1015 | - | - | 119 | 142 | 540 | 119 | 142 | 653 |
| Stage 1 | - | - | - | - | - | - | 524 | 519 | - | 353 | 375 | - |
| Stage 2 | - | - | - | - | - | - | 352 | 373 | - | 522 | 517 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1151 | - | - | 1015 | - | - | 98 | 110 | 540 | 84 | 110 | 653 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 98 | 110 | - | 84 | 110 | - |
| Stage 1 | - | - | - | - | - | - | 524 | 519 | - | 353 | 291 | - |
| Stage 2 | - | - | - | - | - | - | 271 | 289 | - | 459 | 517 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0 | 3.5 | 17.3 | 10.6 |
| HCM LOS | | | C | B |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 104 | 540 | 1151 | - | - | 1015 | - | - | 653 |
| HCM Lane V/C Ratio | 0.105 | 0.111 | - | - | - | 0.225 | - | - | 0.008 |
| HCM Control Delay (s) | 43.6 | 12.5 | 0 | - | - | 9.6 | - | - | 10.6 |
| HCM Lane LOS | E | B | A | - | - | A | - | - | B |
| HCM 95th %tile Q(veh) | 0.3 | 0.4 | 0 | - | - | 0.9 | - | - | 0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Volume (vph) | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 250 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 0 | | 0 | 1 | | 0 | 0 | | 1 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | | |
| Flt Protected | | | | 0.950 | | | | 0.976 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Flt Permitted | | | | 0.950 | | | | 0.976 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 924 | 5 | 5 | 690 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 929 | 0 | 5 | 695 | 0 | 0 | 10 | 60 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 61.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

## HCM Unsignalized Intersection Capacity Analysis
## 54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Volume (Veh/h) | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 924 | 5 | 5 | 690 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 695 | | | 929 | | | 1626 | 1632 | 926 | 1632 | 1632 | 692 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 695 | | | 929 | | | 1626 | 1632 | 926 | 1632 | 1632 | 692 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 99 | | | 94 | 95 | 81 | 92 | 100 | 100 |
| cM capacity (veh/h) | 887 | | | 724 | | | 80 | 99 | 321 | 62 | 99 | 439 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|---|
| Volume Total | 929 | 5 | 695 | 10 | 60 | 5 |
| Volume Left | 0 | 5 | 0 | 5 | 0 | 5 |
| Volume Right | 5 | 0 | 5 | 0 | 60 | 0 |
| cSH | 887 | 724 | 1700 | 89 | 321 | 62 |
| Volume to Capacity | 0.00 | 0.01 | 0.41 | 0.11 | 0.19 | 0.08 |
| Queue Length 95th (ft) | 0 | 1 | 0 | 9 | 17 | 6 |
| Control Delay (s) | 0.0 | 10.0 | 0.0 | 50.7 | 18.8 | 67.9 |
| Lane LOS | | B | | F | C | F |
| Approach Delay (s) | 0.0 | 0.1 | | 23.3 | | 67.9 |
| Approach LOS | | | | C | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 61.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Vol, veh/h | 0 | 850 | 5 | 5 | 635 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | 250 | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 924 | 5 | 5 | 690 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 696 | 0 | 0 | 929 | 0 | 0 | 1631 | 1634 | 927 | 1633 | 1633 | 693 |
| Stage 1 | - | - | - | - | - | - | 927 | 927 | - | 704 | 704 | - |
| Stage 2 | - | - | - | - | - | - | 704 | 707 | - | 929 | 929 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 886 | - | - | 724 | - | - | 80 | 99 | 321 | 80 | 100 | 438 |
| Stage 1 | - | - | - | - | - | - | 318 | 343 | - | 423 | 435 | - |
| Stage 2 | - | - | - | - | - | - | 423 | 434 | - | 317 | 342 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 886 | - | - | 724 | - | - | 80 | 98 | 321 | 62 | 99 | 438 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 80 | 98 | - | 62 | 99 | - |
| Stage 1 | - | - | - | - | - | - | 318 | 343 | - | 423 | 432 | - |
| Stage 2 | - | - | - | - | - | - | 420 | 431 | - | 254 | 342 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0 | 0.1 | 23.8 | 68.6 |
| HCM LOS | | | C | F |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 88 | 321 | 886 | - | - | 724 | - | - | 62 |
| HCM Lane V/C Ratio | 0.124 | 0.186 | - | - | - | 0.008 | - | - | 0.088 |
| HCM Control Delay (s) | 51.6 | 18.8 | 0 | - | - | 10 | - | - | 68.6 |
| HCM Lane LOS | F | C | A | - | - | B | - | - | F |
| HCM 95th %tile Q(veh) | 0.4 | 0.7 | 0 | - | - | 0 | - | - | 0.3 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Future Volume (vph) | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | | |
| Flt Protected | | | | | 0.982 | | | 0.976 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 0 | 1775 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Flt Permitted | | | | | 0.982 | | | 0.976 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 0 | 1775 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 467 | 5 | 190 | 337 | 5 | 5 | 5 | 49 | 5 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 472 | 0 | 0 | 532 | 0 | 0 | 10 | 49 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 63.4% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Future Volume (Veh/h) | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 467 | 5 | 190 | 337 | 5 | 5 | 5 | 49 | 5 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 342 | | | 472 | | | 1189 | 1192 | 470 | 1192 | 1192 | 340 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 342 | | | 472 | | | 1189 | 1192 | 470 | 1192 | 1192 | 340 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 82 | | | 96 | 97 | 92 | 96 | 100 | 100 |
| cM capacity (veh/h) | 1200 | | | 1074 | | | 140 | 152 | 588 | 125 | 152 | 696 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 472 | 532 | 10 | 49 | 5 |
| Volume Left | 0 | 190 | 5 | 0 | 5 |
| Volume Right | 5 | 5 | 0 | 49 | 0 |
| cSH | 1200 | 1074 | 146 | 588 | 125 |
| Volume to Capacity | 0.00 | 0.18 | 0.07 | 0.08 | 0.04 |
| Queue Length 95th (ft) | 0 | 16 | 5 | 7 | 3 |
| Control Delay (s) | 0.0 | 4.5 | 31.5 | 11.7 | 35.0 |
| Lane LOS | | A | D | B | D |
| Approach Delay (s) | 0.0 | 4.5 | 15.0 | | 35.0 |
| Approach LOS | | | C | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.3 | | |
| Intersection Capacity Utilization | 63.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.6 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Future Vol, veh/h | 0 | 430 | 5 | 175 | 310 | 5 | 5 | 5 | 45 | 5 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 467 | 5 | 190 | 337 | 5 | 5 | 5 | 49 | 5 | 0 | 0 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 342 | 0 | 0 | 473 | 0 | 0 | 1190 | 1193 | 470 | 1193 | 1193 | 340 |
| Stage 1 | - | - | - | - | - | - | 470 | 470 | - | 720 | 720 | - |
| Stage 2 | - | - | - | - | - | - | 720 | 723 | - | 473 | 473 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 1200 | - | - | 1073 | - | - | 162 | 184 | 587 | 161 | 184 | 696 |
| Stage 1 | - | - | - | - | - | - | 568 | 555 | - | 414 | 428 | - |
| Stage 2 | - | - | - | - | - | - | 414 | 426 | - | 566 | 553 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1200 | - | - | 1073 | - | - | 135 | 144 | 587 | 119 | 144 | 696 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 135 | 144 | - | 119 | 144 | - |
| Stage 1 | - | - | - | - | - | - | 568 | 555 | - | 414 | 334 | - |
| Stage 2 | - | - | - | - | - | - | 323 | 333 | - | 514 | 553 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0 | 3.2 | 15.6 | 36.7 |
| HCM LOS | | | C | E |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 139 | 587 | 1200 | - | - | 1073 | - | - | 119 |
| HCM Lane V/C Ratio | 0.078 | 0.083 | - | - | - | 0.177 | - | - | 0.046 |
| HCM Control Delay (s) | 33.1 | 11.7 | 0 | - | - | 9.1 | - | - | 36.7 |
| HCM Lane LOS | D | B | A | - | - | A | - | - | E |
| HCM 95th %tile Q(veh) | 0.3 | 0.3 | 0 | - | - | 0.6 | - | - | 0.1 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Volume (vph) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | | |
| Flt Protected | | | | | 0.982 | | | 0.976 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 0 | 1775 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Flt Permitted | | | | | 0.982 | | | 0.976 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 0 | 1775 | 0 | 0 | 1766 | 1538 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 538 | 0 | 0 | 619 | 0 | 0 | 10 | 60 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 70.9% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Volume (Veh/h) | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 391 | | | 538 | | | 1380 | 1382 | 536 | 1382 | 1382 | 388 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 391 | | | 538 | | | 1380 | 1382 | 536 | 1382 | 1382 | 388 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 78 | | | 95 | 95 | 89 | 94 | 100 | 100 |
| cM capacity (veh/h) | 1151 | | | 1015 | | | 99 | 110 | 539 | 85 | 110 | 653 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 538 | 619 | 10 | 60 | 5 |
| Volume Left | 0 | 228 | 5 | 0 | 5 |
| Volume Right | 5 | 5 | 0 | 60 | 0 |
| cSH | 1151 | 1015 | 104 | 539 | 85 |
| Volume to Capacity | 0.00 | 0.22 | 0.10 | 0.11 | 0.06 |
| Queue Length 95th (ft) | 0 | 22 | 8 | 9 | 5 |
| Control Delay (s) | 0.0 | 5.3 | 43.2 | 12.5 | 50.1 |
| Lane LOS | | A | E | B | F |
| Approach Delay (s) | 0.0 | 5.3 | 16.9 | | 50.1 |
| Approach LOS | | | C | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.8 | | |
| Intersection Capacity Utilization | 70.9% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 3 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Future Vol, veh/h | 0 | 490 | 5 | 210 | 355 | 5 | 5 | 5 | 55 | 5 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 0 | 533 | 5 | 228 | 386 | 5 | 5 | 5 | 60 | 5 | 0 | 0 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 391 | 0 | 0 | 538 | 0 | 0 | 1380 | 1383 | 535 | 1383 | 1383 | 389 |
| Stage 1 | - | - | - | - | - | - | 535 | 535 | - | 845 | 845 | - |
| Stage 2 | - | - | - | - | - | - | 845 | 848 | - | 538 | 538 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 1151 | - | - | 1015 | - | - | 120 | 142 | 540 | 119 | 142 | 653 |
| Stage 1 | - | - | - | - | - | - | 524 | 519 | - | 353 | 375 | - |
| Stage 2 | - | - | - | - | - | - | 353 | 373 | - | 522 | 517 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1151 | - | - | 1015 | - | - | 93 | 101 | 540 | 79 | 101 | 653 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 93 | 101 | - | 79 | 101 | - |
| Stage 1 | - | - | - | - | - | - | 524 | 519 | - | 353 | 267 | - |
| Stage 2 | - | - | - | - | - | - | 252 | 266 | - | 459 | 517 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0 | 3.5 | 17.8 | 53.9 |
| HCM LOS | | | C | F |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 97 | 540 | 1151 | - | - | 1015 | - | - | 79 |
| HCM Lane V/C Ratio | 0.112 | 0.111 | - | - | - | 0.225 | - | - | 0.069 |
| HCM Control Delay (s) | 46.7 | 12.5 | 0 | - | - | 9.6 | - | - | 53.9 |
| HCM Lane LOS | E | B | A | - | - | A | - | - | F |
| HCM 95th %tile Q(veh) | 0.4 | 0.4 | 0 | - | - | 0.9 | - | - | 0.2 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (vph) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 250 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 0 | | 0 | 1 | | 0 | 0 | | 1 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | 0.950 | | | | 0.958 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | 0.950 | | | | 0.958 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 619 | 0 | 717 | 619 | 0 | 0 | 38 | 71 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 85.2% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 619 | | | 614 | | | 2674 | 2674 | 612 | 2674 | 2674 | 616 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 619 | | | 614 | | | 2674 | 2674 | 612 | 2674 | 2674 | 616 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 25 | | | 0 | 6 | 85 | 100 | 100 | 99 |
| cM capacity (veh/h) | 947 | | | 951 | | | 5 | 5 | 488 | 1 | 5 | 485 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|---|
| Volume Total | 619 | 717 | 619 | 38 | 71 | 5 |
| Volume Left | 5 | 717 | 0 | 33 | 0 | 0 |
| Volume Right | 5 | 0 | 5 | 0 | 71 | 5 |
| cSH | 947 | 951 | 1700 | 5 | 488 | 485 |
| Volume to Capacity | 0.01 | 0.75 | 0.36 | 7.11 | 0.15 | 0.01 |
| Queue Length 95th (ft) | 0 | 184 | 0 | Err | 13 | 1 |
| Control Delay (s) | 0.1 | 19.4 | 0.0 | Err | 13.6 | 12.5 |
| Lane LOS | A | C | | F | B | B |
| Approach Delay (s) | 0.1 | 10.4 | | 3494.8 | | 12.5 |
| Approach LOS | | | | F | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 190.9 | | |
| Intersection Capacity Utilization | 85.2% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 87.6 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Vol, veh/h | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | 250 | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 620 | 0 | 0 | 614 | 0 | 0 | 2676 | 2676 | 611 | 2677 | 2677 | 617 |
| Stage 1 | - | - | - | - | - | - | 622 | 622 | - | 2052 | 2052 | - |
| Stage 2 | - | - | - | - | - | - | 2054 | 2054 | - | 625 | 625 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 946 | - | - | 951 | - | - | ~ 14 | 22 | 488 | 14 | 22 | 484 |
| Stage 1 | - | - | - | - | - | - | 469 | 474 | - | 71 | 96 | - |
| Stage 2 | - | - | - | - | - | - | 71 | 96 | - | 468 | 473 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 946 | - | - | 951 | - | - | ~ 5 | ~ 5 | 488 | - | 5 | 484 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 5 | ~ 5 | - | - | 5 | - |
| Stage 1 | - | - | - | - | - | - | 465 | 470 | - | 70 | 24 | - |
| Stage 2 | - | - | - | - | - | - | ~ 17 | 24 | - | 392 | 469 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | 10.4 | $ 1539.9 | |
| HCM LOS | | | F | - |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 5 | 488 | 946 | - | - | 951 | - | - | - |
| HCM Lane V/C Ratio | 7.609 | 0.145 | 0.006 | - | - | 0.754 | - | - | - |
| HCM Control Delay (s) | $ 4374.4 | 13.6 | 8.8 | 0 | - | 19.4 | - | - | - |
| HCM Lane LOS | F | B | A | A | - | C | - | - | - |
| HCM 95th %tile Q(veh) | 6.4 | 0.5 | 0 | - | - | 7.4 | - | - | - |

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A 02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (vph) | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 250 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 0 | | 0 | 1 | | 0 | 0 | | 1 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | 0.950 | | | | 0.958 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | 0.950 | | | | 0.958 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 1719 | 1808 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 1201 | 5 | 277 | 989 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1211 | 0 | 277 | 994 | 0 | 0 | 38 | 71 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 125.5% | ICU Level of Service H |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 1201 | 5 | 277 | 989 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 994 | | | 1206 | | | 2762 | 2762 | 1204 | 2762 | 2762 | 992 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 994 | | | 1206 | | | 2762 | 2762 | 1204 | 2762 | 2762 | 992 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 51 | | | 0 | 48 | 68 | 100 | 100 | 98 |
| cM capacity (veh/h) | 684 | | | 568 | | | 7 | 10 | 221 | 3 | 10 | 295 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|---|
| Volume Total | 1211 | 277 | 994 | 38 | 71 | 5 |
| Volume Left | 5 | 277 | 0 | 33 | 0 | 0 |
| Volume Right | 5 | 0 | 5 | 0 | 71 | 5 |
| cSH | 684 | 568 | 1700 | 8 | 221 | 295 |
| Volume to Capacity | 0.01 | 0.49 | 0.58 | 4.98 | 0.32 | 0.02 |
| Queue Length 95th (ft) | 1 | 67 | 0 | Err | 33 | 1 |
| Control Delay (s) | 0.3 | 17.2 | 0.0 | Err | 28.8 | 17.4 |
| Lane LOS | A | C | | F | D | C |
| Approach Delay (s) | 0.3 | 3.8 | | 3504.6 | | 17.4 |
| Approach LOS | | | | F | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 149.2 | | |
| Intersection Capacity Utilization | 125.5% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 46.9 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Vol, veh/h | 5 | 1105 | 5 | 255 | 910 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | 250 | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 5 | 1201 | 5 | 277 | 989 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 995 | 0 | 0 | 1207 | 0 | 0 | 2764 | 2764 | 1204 | 2763 | 2763 | 992 |
| Stage 1 | - | - | - | - | - | - | 1215 | 1215 | - | 1546 | 1546 | - |
| Stage 2 | - | - | - | - | - | - | 1549 | 1549 | - | 1217 | 1217 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 683 | - | - | 568 | - | - | ~ 12 | 19 | 221 | 12 | 19 | 294 |
| Stage 1 | - | - | - | - | - | - | 219 | 251 | - | 141 | 173 | - |
| Stage 2 | - | - | - | - | - | - | 140 | 172 | - | 218 | 250 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 683 | - | - | 568 | - | - | ~ 7 | 10 | 221 | 3 | 10 | 294 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 7 | 10 | - | 3 | 10 | - |
| Stage 1 | - | - | - | - | - | - | 214 | 245 | - | 138 | 89 | - |
| Stage 2 | - | - | - | - | - | - | 70 | 88 | - | 142 | 245 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0 | 3.8 | $ 1075.1 | 17.5 |
| HCM LOS | | | F | C |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 7 | 221 | 683 | - | - | 568 | - | - | 294 |
| HCM Lane V/C Ratio | 5.435 | 0.32 | 0.008 | - | - | 0.488 | - | - | 0.018 |
| HCM Control Delay (s) | $ 3018.3 | 28.8 | 10.3 | 0 | - | 17.2 | - | - | 17.5 |
| HCM Lane LOS | F | D | B | A | - | C | - | - | C |
| HCM 95th %tile Q(veh) | 6.2 | 1.3 | 0 | - | - | 2.7 | - | - | 0.1 |

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Future Volume (vph) | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | | 0.975 | | | 0.960 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 0 | 1763 | 0 | 0 | 1737 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | | 0.975 | | | 0.960 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 0 | 1763 | 0 | 0 | 1737 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 522 | 5 | 630 | 582 | 5 | 27 | 5 | 60 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 532 | 0 | 0 | 1217 | 0 | 0 | 32 | 60 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 104.7% ICU Level of Service G

Analysis Period (min) 15

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 522 | 5 | 630 | 582 | 5 | 27 | 5 | 60 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 587 | | | 527 | | | 2384 | 2382 | 524 | 2382 | 2382 | 584 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 587 | | | 527 | | | 2384 | 2382 | 524 | 2382 | 2382 | 584 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 39 | | | 0 | 61 | 89 | 100 | 100 | 99 |
| cM capacity (veh/h) | 973 | | | 1025 | | | 12 | 13 | 547 | 8 | 13 | 506 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 532 | 1217 | 32 | 60 | 5 |
| Volume Left | 5 | 630 | 27 | 0 | 0 |
| Volume Right | 5 | 5 | 0 | 60 | 5 |
| cSH | 973 | 1025 | 12 | 547 | 506 |
| Volume to Capacity | 0.01 | 0.61 | 2.71 | 0.11 | 0.01 |
| Queue Length 95th (ft) | 0 | 110 | 124 | 9 | 1 |
| Control Delay (s) | 0.1 | 13.5 | 1415.7 | 12.4 | 12.2 |
| Lane LOS | A | B | F | B | B |
| Approach Delay (s) | 0.1 | 13.5 | 500.5 | | 12.2 |
| Approach LOS | | | F | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 33.9 | | |
| Intersection Capacity Utilization | 104.7% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 73.6 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Future Vol, veh/h | 5 | 480 | 5 | 580 | 535 | 5 | 25 | 5 | 55 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 5 | 522 | 5 | 630 | 582 | 5 | 27 | 5 | 60 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 587 | 0 | 0 | 527 | 0 | 0 | 2383 | 2383 | 524 | 2383 | 2383 | 584 |
| Stage 1 | - | - | - | - | - | - | 535 | 535 | - | 1845 | 1845 | - |
| Stage 2 | - | - | - | - | - | - | 1848 | 1848 | - | 538 | 538 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 973 | - | - | 1025 | - | - | ~ 23 | 34 | 547 | 23 | 34 | 506 |
| Stage 1 | - | - | - | - | - | - | 524 | 519 | - | 94 | 123 | - |
| Stage 2 | - | - | - | - | - | - | 94 | 122 | - | 522 | 517 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 973 | - | - | 1025 | - | - | ~ 5 | ~ 3 | 547 | - | 3 | 506 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 5 | ~ 3 | - | - | 3 | - |
| Stage 1 | - | - | - | - | - | - | 520 | 515 | - | 93 | 11 | - |
| Stage 2 | - | - | - | - | - | - | ~ 8 | 11 | - | 457 | 513 | - |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | 7.2 | $ 1377.3 | |
| HCM LOS | | | F | - |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 5 | 547 | 973 | - | - | 1025 | - | - | - |
| HCM Lane V/C Ratio | 6.522 | 0.109 | 0.006 | - | - | 0.615 | - | - | - |
| HCM Control Delay (s) | $ 3879.6 | 12.4 | 8.7 | 0 | - | 14 | - | - | - |
| HCM Lane LOS | F | B | A | A | - | B | - | - | - |
| HCM 95th %tile Q(veh) | 5.6 | 0.4 | 0 | - | - | 4.4 | - | - | - |

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (vph) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | 0.999 | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | | 0.974 | | | 0.958 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 0 | 1761 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | | 0.974 | | | 0.958 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 0 | 1761 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 619 | 0 | 0 | 1336 | 0 | 0 | 38 | 71 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 115.2% | ICU Level of Service H |
| Analysis Period (min) 15 | |

## HCM Unsignalized Intersection Capacity Analysis
## 54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A

02/05/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 619 | | | 614 | | | 2677 | 2674 | 612 | 2674 | 2674 | 616 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 619 | | | 614 | | | 2677 | 2674 | 612 | 2674 | 2674 | 616 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 25 | | | 0 | 6 | 85 | 100 | 100 | 99 |
| cM capacity (veh/h) | 947 | | | 951 | | | 5 | 5 | 488 | 1 | 5 | 485 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 619 | 1336 | 38 | 71 | 5 |
| Volume Left | 5 | 717 | 33 | 0 | 0 |
| Volume Right | 5 | 5 | 0 | 71 | 5 |
| cSH | 947 | 951 | 5 | 488 | 485 |
| Volume to Capacity | 0.01 | 0.75 | 7.13 | 0.15 | 0.01 |
| Queue Length 95th (ft) | 0 | 184 | Err | 13 | 1 |
| Control Delay (s) | 0.1 | 19.4 | Err | 13.6 | 12.5 |
| Lane LOS | A | C | F | B | B |
| Approach Delay (s) | 0.1 | 19.4 | 3494.8 | | 12.5 |
| Approach LOS | | | F | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 196.7 | | |
| Intersection Capacity Utilization | 115.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

HCM 2010 TWSC
54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A 02/05/2018

| Intersection | |
|---|---|
| Int Delay, s/veh | 6.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Vol, veh/h | 5 | 560 | 5 | 660 | 565 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | Yield | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | 0 | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 5 | 609 | 5 | 717 | 614 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 620 | 0 | 0 | 614 | 0 | 0 | 2676 | 2676 | 611 | 2677 | 2677 | 617 |
| Stage 1 | - | - | - | - | - | - | 622 | 622 | - | 2052 | 2052 | - |
| Stage 2 | - | - | - | - | - | - | 2054 | 2054 | - | 625 | 625 | - |
| Critical Hdwy | 4.15 | - | - | 4.15 | - | - | 7.15 | 6.55 | 6.25 | 7.15 | 6.55 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.15 | 5.55 | - | 6.15 | 5.55 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.245 | - | - | 3.545 | 4.045 | 3.345 | 3.545 | 4.045 | 3.345 |
| Pot Cap-1 Maneuver | 946 | - | - | 951 | - | - | ~ 14 | 22 | 488 | 14 | 22 | 484 |
| Stage 1 | - | - | - | - | - | - | 469 | 474 | - | 71 | 96 | - |
| Stage 2 | - | - | - | - | - | - | 71 | 96 | - | 468 | 473 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 946 | - | - | 951 | - | - | - | 0 | 488 | - | 0 | 484 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | - | 0 | - | - | 0 | - |
| Stage 1 | - | - | - | - | - | - | 465 | 470 | - | 70 | 0 | - |
| Stage 2 | - | - | - | - | - | - | - | 0 | - | 392 | 469 | - |

| Approach | EB | | | WB | | | NE | | | SW | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HCM Control Delay, s | 0.1 | | | 10.4 | | | | | | | | |
| HCM LOS | | | | | | | - | | | - | | |

| Minor Lane/Major Mvmt | NELn1 | NELn2 | EBL | EBT | EBR | WBL | WBT | WBR | SWLn1 |
|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | 488 | 946 | - | - | 951 | - | - | - |
| HCM Lane V/C Ratio | - | 0.145 | 0.006 | - | - | 0.754 | - | - | - |
| HCM Control Delay (s) | - | 13.6 | 8.8 | 0 | - | 19.4 | - | - | - |
| HCM Lane LOS | - | B | A | A | - | C | - | - | - |
| HCM 95th %tile Q(veh) | - | 0.5 | 0 | - | - | 7.4 | - | - | - |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

## Lanes, Volumes, Timings
## 69: Canal Rd & Scenic Hwy/Meetinghouse Ln

02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.937 | | | 0.969 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.121 | | | 0.539 | | | 0.950 | | | 0.657 | | |
| Satd. Flow (perm) | 225 | 1863 | 1583 | 1004 | 1745 | 0 | 1770 | 1805 | 0 | 1224 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 228 | | 23 | | | 9 | | | | 163 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 935 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 935 | 375 | 228 | 22 | 375 | 0 | 190 | 158 | 0 | 38 | 33 | 163 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 2 | 2 | | 3 | 8 | | 4 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | | 4.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 17.0 | 17.0 | 17.0 | 17.0 | | 11.0 | 17.0 | | 17.0 | 17.0 | 17.0 |
| Total Split (s) | 69.0 | 102.0 | 102.0 | 33.0 | 33.0 | | 21.0 | 38.0 | | 17.0 | 17.0 | 17.0 |
| Total Split (%) | 49.3% | 72.9% | 72.9% | 23.6% | 23.6% | | 15.0% | 27.1% | | 12.1% | 12.1% | 12.1% |
| Maximum Green (s) | 62.0 | 95.0 | 95.0 | 26.0 | 26.0 | | 14.0 | 31.0 | | 10.0 | 10.0 | 10.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | C-Max | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 95.0 | 95.0 | 95.0 | 26.0 | 26.0 | | 14.0 | 31.0 | | 10.0 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.68 | 0.68 | 0.68 | 0.19 | 0.19 | | 0.10 | 0.22 | | 0.07 | 0.07 | 0.07 |
| v/c Ratio | 1.12 | 0.30 | 0.20 | 0.12 | 1.10 | | 1.07 | 0.39 | | 0.44 | 0.25 | 0.62 |
| Control Delay | 101.1 | 9.8 | 1.3 | 49.5 | 125.8 | | 146.3 | 47.0 | | 78.4 | 66.4 | 19.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 101.1 | 9.8 | 1.3 | 49.5 | 125.8 | | 146.3 | 47.0 | | 78.4 | 66.4 | 19.5 |
| LOS | F | A | A | D | F | | F | D | | E | E | B |
| Approach Delay | | 64.0 | | | 121.5 | | | 101.2 | | | 35.7 | |
| Approach LOS | | E | | | F | | | F | | | D | |
| Queue Length 50th (ft) | ~927 | 127 | 0 | 17 | ~367 | | ~192 | 116 | | 34 | 29 | 0 |
| Queue Length 95th (ft) | #1188 | 177 | 26 | 44 | #574 | | #352 | 187 | | 74 | 66 | 72 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 836 | 1264 | 1147 | 186 | 342 | | 177 | 406 | | 87 | 133 | 264 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.12 | 0.30 | 0.20 | 0.12 | 1.10 | | 1.07 | 0.39 | | 0.44 | 0.25 | 0.62 |

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green

Natural Cycle: 150

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.12

Intersection Signal Delay: 75.6 Intersection LOS: E

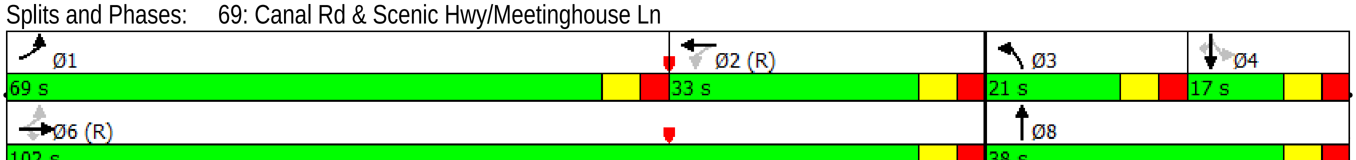
Intersection Capacity Utilization 108.4% ICU Level of Service G

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.94 | | 1.00 | 0.97 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | | 1770 | 1804 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.12 | 1.00 | 1.00 | 0.54 | 1.00 | | 0.95 | 1.00 | | 0.66 | 1.00 | 1.00 |
| Satd. Flow (perm) | 226 | 1863 | 1583 | 1003 | 1745 | | 1770 | 1804 | | 1223 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 935 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| RTOR Reduction (vph) | 0 | 0 | 73 | 0 | 19 | 0 | 0 | 7 | 0 | 0 | 0 | 151 |
| Lane Group Flow (vph) | 935 | 375 | 155 | 22 | 356 | 0 | 190 | 151 | 0 | 38 | 33 | 12 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | 4 | | 4 |
| Actuated Green, G (s) | 95.0 | 95.0 | 95.0 | 26.0 | 26.0 | | 14.0 | 31.0 | | 10.0 | 10.0 | 10.0 |
| Effective Green, g (s) | 95.0 | 95.0 | 95.0 | 26.0 | 26.0 | | 14.0 | 31.0 | | 10.0 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.68 | 0.68 | 0.68 | 0.19 | 0.19 | | 0.10 | 0.22 | | 0.07 | 0.07 | 0.07 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 837 | 1264 | 1074 | 186 | 324 | | 177 | 399 | | 87 | 133 | 113 |
| v/s Ratio Prot | c0.49 | 0.20 | | | 0.20 | | c0.11 | c0.08 | | | 0.02 | |
| v/s Ratio Perm | c0.26 | | 0.10 | 0.02 | | | | | | 0.03 | | 0.01 |
| v/c Ratio | 1.12 | 0.30 | 0.14 | 0.12 | 1.10 | | 1.07 | 0.38 | | 0.44 | 0.25 | 0.10 |
| Uniform Delay, d1 | 34.0 | 9.1 | 8.0 | 47.5 | 57.0 | | 63.0 | 46.3 | | 62.3 | 61.4 | 60.8 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 68.5 | 0.6 | 0.3 | 1.3 | 79.4 | | 88.5 | 0.6 | | 3.5 | 1.0 | 0.4 |
| Delay (s) | 102.5 | 9.7 | 8.3 | 48.8 | 136.4 | | 151.5 | 46.9 | | 65.8 | 62.4 | 61.2 |
| Level of Service | F | A | A | D | F | | F | D | | E | E | E |
| Approach Delay (s) | | 65.9 | | | 131.6 | | | 104.0 | | | 62.1 | |
| Approach LOS | | E | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 81.2 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.08 | | |
| Actuated Cycle Length (s) | 140.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 108.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | ↰ | ↑ | ↱ | ↰ | ↱ |  | ↰ | ↱ |  | ↰ | ↑ | ↱ |
| Traffic Volume (veh/h) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (veh/h) | 860 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 |  | 1.00 | 1.00 |  | 1.00 | 1.00 |  | 1.00 | 1.00 |  | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 935 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 0 | 38 | 33 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 837 | 1264 | 1074 | 202 | 186 | 136 | 177 | 412 | 0 | 141 | 133 | 113 |
| Arrive On Green | 0.44 | 0.68 | 0.68 | 0.19 | 0.19 | 0.19 | 0.10 | 0.22 | 0.00 | 0.07 | 0.07 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 813 | 1003 | 731 | 1774 | 1863 | 0 | 1261 | 1863 | 1583 |
| Grp Volume(v), veh/h | 935 | 375 | 228 | 22 | 0 | 375 | 190 | 125 | 0 | 38 | 33 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 813 | 0 | 1734 | 1774 | 1863 | 0 | 1261 | 1863 | 1583 |
| Q Serve(g_s), s | 62.0 | 11.3 | 7.6 | 3.2 | 0.0 | 26.0 | 14.0 | 7.8 | 0.0 | 4.0 | 2.3 | 0.0 |
| Cycle Q Clear(g_c), s | 62.0 | 11.3 | 7.6 | 3.2 | 0.0 | 26.0 | 14.0 | 7.8 | 0.0 | 4.0 | 2.3 | 0.0 |
| Prop In Lane | 1.00 |  | 1.00 | 1.00 |  | 0.42 | 1.00 |  | 0.00 | 1.00 |  | 1.00 |
| Lane Grp Cap(c), veh/h | 837 | 1264 | 1074 | 202 | 0 | 322 | 177 | 412 | 0 | 141 | 133 | 113 |
| V/C Ratio(X) | 1.12 | 0.30 | 0.21 | 0.11 | 0.00 | 1.16 | 1.07 | 0.30 | 0.00 | 0.27 | 0.25 | 0.00 |
| Avail Cap(c_a), veh/h | 837 | 1264 | 1074 | 202 | 0 | 322 | 177 | 412 | 0 | 141 | 133 | 113 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 34.0 | 9.1 | 8.4 | 47.7 | 0.0 | 57.0 | 63.0 | 45.5 | 0.0 | 62.2 | 61.5 | 0.0 |
| Incr Delay (d2), s/veh | 68.4 | 0.6 | 0.5 | 1.1 | 0.0 | 102.5 | 87.7 | 0.4 | 0.0 | 1.0 | 1.0 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 48.2 | 6.0 | 3.4 | 0.8 | 0.0 | 21.6 | 11.2 | 4.1 | 0.0 | 1.5 | 1.2 | 0.0 |
| LnGrp Delay(d),s/veh | 102.5 | 9.7 | 8.9 | 48.8 | 0.0 | 159.5 | 150.7 | 45.9 | 0.0 | 63.2 | 62.4 | 0.0 |
| LnGrp LOS | F | A | A | D |  | F | F | D |  | E | E |  |
| Approach Vol, veh/h |  | 1538 |  |  | 397 |  |  | 315 |  |  | 71 |  |
| Approach Delay, s/veh |  | 66.0 |  |  | 153.4 |  |  | 109.1 |  |  | 62.9 |  |
| Approach LOS |  | E |  |  | F |  |  | F |  |  | E |  |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 |  | 6 |  | 8 |
| Phs Duration (G+Y+Rc), s | 69.0 | 33.0 | 21.0 | 17.0 |  | 102.0 |  | 38.0 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 |  | 7.0 |  | 7.0 |
| Max Green Setting (Gmax), s | 62.0 | 26.0 | 14.0 | 10.0 |  | 95.0 |  | 31.0 |
| Max Q Clear Time (g_c+I1), s | 64.0 | 28.0 | 16.0 | 6.0 |  | 13.3 |  | 9.8 |
| Green Ext Time (p_c), s | 0.0 | 0.0 | 0.0 | 0.3 |  | 7.0 |  | 0.9 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 86.7 |
| HCM 2010 LOS | | F |

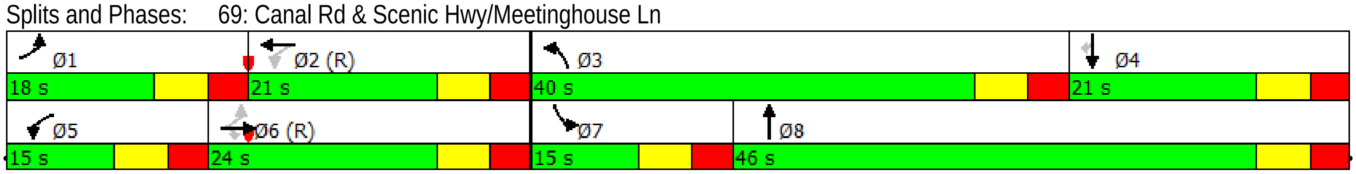
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Future Volume (vph) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.957 | | | 0.969 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1783 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.220 | | | 0.592 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (perm) | 410 | 1863 | 1583 | 1103 | 1783 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 273 | | 17 | | | 15 | | | | 273 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 522 | 272 | 190 | 16 | 174 | 71 | 158 | 103 | 27 | 27 | 27 | 125 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 522 | 272 | 190 | 16 | 245 | 0 | 158 | 130 | 0 | 27 | 27 | 125 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Detector Phase | 1 | 6 | 6 | 5 | 2 | | 3 | 8 | | 7 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 10.0 | 10.0 | 4.0 | 10.0 | | 4.0 | 10.0 | | 4.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 17.0 | 17.0 | 11.0 | 17.0 | | 11.0 | 17.0 | | 11.0 | 17.0 | 17.0 |
| Total Split (s) | 18.0 | 24.0 | 24.0 | 15.0 | 21.0 | | 40.0 | 46.0 | | 15.0 | 21.0 | 21.0 |
| Total Split (%) | 18.0% | 24.0% | 24.0% | 15.0% | 21.0% | | 40.0% | 46.0% | | 15.0% | 21.0% | 21.0% |
| Maximum Green (s) | 11.0 | 17.0 | 17.0 | 8.0 | 14.0 | | 33.0 | 39.0 | | 8.0 | 14.0 | 14.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | Lag | Lag | Lead | Lag | | Lead | Lag | | Lead | Lag | Lag |
| Lead-Lag Optimize? | Yes | Yes | Yes | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | None | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 54.7 | 49.3 | 49.3 | 20.0 | 14.0 | | 14.3 | 22.6 | | 6.9 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.55 | 0.49 | 0.49 | 0.20 | 0.14 | | 0.14 | 0.23 | | 0.07 | 0.10 | 0.10 |
| v/c Ratio | 0.77 | 0.30 | 0.21 | 0.06 | 0.93 | | 0.62 | 0.31 | | 0.22 | 0.15 | 0.31 |
| Control Delay | 28.5 | 19.0 | 1.0 | 17.5 | 80.7 | | 50.7 | 31.9 | | 48.1 | 43.2 | 2.0 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 28.5 | 19.0 | 1.0 | 17.5 | 80.7 | | 50.7 | 31.9 | | 48.1 | 43.2 | 2.0 |
| LOS | C | B | A | B | F | | D | C | | D | D | A |
| Approach Delay | | 20.6 | | | 76.8 | | | 42.2 | | | 15.2 | |
| Approach LOS | | C | | | E | | | D | | | B | |
| Queue Length 50th (ft) | 225 | 87 | 0 | 4 | 146 | | 96 | 65 | | 17 | 16 | 0 |
| Queue Length 95th (ft) | #450 | 202 | 8 | 16 | #295 | | 153 | 116 | | 44 | 42 | 0 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 682 | 918 | 918 | 296 | 264 | | 584 | 713 | | 141 | 260 | 456 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.77 | 0.30 | 0.21 | 0.05 | 0.93 | | 0.27 | 0.18 | | 0.19 | 0.10 | 0.27 |

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.93
Intersection Signal Delay: 32.2 Intersection LOS: C
Intersection Capacity Utilization 71.2% ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Future Volume (vph) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.96 | | 1.00 | 0.97 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1782 | | 1770 | 1805 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.22 | 1.00 | 1.00 | 0.59 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 409 | 1863 | 1583 | 1103 | 1782 | | 1770 | 1805 | | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 522 | 272 | 190 | 16 | 174 | 71 | 158 | 103 | 27 | 27 | 27 | 125 |
| RTOR Reduction (vph) | 0 | 0 | 110 | 0 | 15 | 0 | 0 | 12 | 0 | 0 | 0 | 109 |
| Lane Group Flow (vph) | 522 | 272 | 80 | 16 | 230 | 0 | 158 | 118 | 0 | 27 | 27 | 16 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Actuated Green, G (s) | 51.9 | 42.3 | 42.3 | 13.8 | 11.2 | | 14.3 | 22.6 | | 4.5 | 12.8 | 12.8 |
| Effective Green, g (s) | 51.9 | 42.3 | 42.3 | 13.8 | 11.2 | | 14.3 | 22.6 | | 4.5 | 12.8 | 12.8 |
| Actuated g/C Ratio | 0.52 | 0.42 | 0.42 | 0.14 | 0.11 | | 0.14 | 0.23 | | 0.04 | 0.13 | 0.13 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 670 | 788 | 669 | 169 | 199 | | 253 | 407 | | 79 | 238 | 202 |
| v/s Ratio Prot | c0.26 | 0.15 | | 0.00 | c0.13 | | c0.09 | c0.07 | | 0.02 | 0.01 | |
| v/s Ratio Perm | 0.14 | | 0.05 | 0.01 | | | | | | | | 0.01 |
| v/c Ratio | 0.78 | 0.35 | 0.12 | 0.09 | 1.16 | | 0.62 | 0.29 | | 0.34 | 0.11 | 0.08 |
| Uniform Delay, d1 | 20.5 | 19.5 | 17.5 | 37.5 | 44.4 | | 40.3 | 32.1 | | 46.3 | 38.6 | 38.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 5.7 | 1.2 | 0.4 | 0.2 | 111.9 | | 4.7 | 0.4 | | 2.6 | 0.2 | 0.2 |
| Delay (s) | 26.2 | 20.7 | 17.9 | 37.7 | 156.3 | | 45.1 | 32.5 | | 48.9 | 38.8 | 38.6 |
| Level of Service | C | C | B | D | F | | D | C | | D | D | D |
| Approach Delay (s) | | 23.1 | | | 149.0 | | | 39.4 | | | 40.2 | |
| Approach LOS | | C | | | F | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 46.8 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 100.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 71.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Future Volume (veh/h) | 480 | 250 | 175 | 15 | 160 | 65 | 145 | 95 | 25 | 25 | 25 | 115 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 522 | 272 | 190 | 16 | 174 | 71 | 158 | 103 | 0 | 27 | 27 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 612 | 926 | 787 | 469 | 505 | 206 | 195 | 349 | 0 | 37 | 184 | 156 |
| Arrive On Green | 0.11 | 0.50 | 0.50 | 0.01 | 0.40 | 0.40 | 0.11 | 0.19 | 0.00 | 0.02 | 0.10 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 1774 | 1259 | 514 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Grp Volume(v), veh/h | 522 | 272 | 190 | 16 | 0 | 245 | 158 | 103 | 0 | 27 | 27 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 1774 | 0 | 1772 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Q Serve(g_s), s | 11.0 | 8.6 | 6.9 | 0.5 | 0.0 | 9.6 | 8.7 | 4.8 | 0.0 | 1.5 | 1.3 | 0.0 |
| Cycle Q Clear(g_c), s | 11.0 | 8.6 | 6.9 | 0.5 | 0.0 | 9.6 | 8.7 | 4.8 | 0.0 | 1.5 | 1.3 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.29 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 612 | 926 | 787 | 469 | 0 | 712 | 195 | 349 | 0 | 37 | 184 | 156 |
| V/C Ratio(X) | 0.85 | 0.29 | 0.24 | 0.03 | 0.00 | 0.34 | 0.81 | 0.30 | 0.00 | 0.72 | 0.15 | 0.00 |
| Avail Cap(c_a), veh/h | 612 | 926 | 787 | 586 | 0 | 712 | 585 | 726 | 0 | 142 | 261 | 222 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 22.1 | 14.8 | 14.4 | 17.2 | 0.0 | 20.8 | 43.5 | 35.0 | 0.0 | 48.7 | 41.2 | 0.0 |
| Incr Delay (d2), s/veh | 11.2 | 0.8 | 0.7 | 0.0 | 0.0 | 1.3 | 7.9 | 0.5 | 0.0 | 22.7 | 0.4 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 10.4 | 4.6 | 3.1 | 0.3 | 0.0 | 5.0 | 4.7 | 2.5 | 0.0 | 1.0 | 0.7 | 0.0 |
| LnGrp Delay(d),s/veh | 33.3 | 15.6 | 15.1 | 17.2 | 0.0 | 22.1 | 51.4 | 35.4 | 0.0 | 71.4 | 41.6 | 0.0 |
| LnGrp LOS | C | B | B | B | | C | D | D | | E | D | |
| Approach Vol, veh/h | | 984 | | | 261 | | | 261 | | | 54 | |
| Approach Delay, s/veh | | 24.9 | | | 21.8 | | | 45.1 | | | 56.5 | |
| Approach LOS | | C | | | C | | | D | | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | 18.0 | 47.2 | 18.0 | 16.9 | 8.4 | 56.7 | 9.1 | 25.7 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Max Green Setting (Gmax), s | 11.0 | 14.0 | 33.0 | 14.0 | 8.0 | 17.0 | 8.0 | 39.0 |
| Max Q Clear Time (g_c+I1), s | 13.0 | 11.6 | 10.7 | 3.3 | 2.5 | 10.6 | 3.5 | 6.8 |
| Green Ext Time (p_c), s | 0.0 | 0.9 | 0.4 | 0.4 | 0.0 | 2.1 | 0.0 | 0.7 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 28.8 |
| HCM 2010 LOS | C |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.937 | | | 0.969 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.220 | | | 0.539 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (perm) | 410 | 1863 | 1583 | 1004 | 1745 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 273 | | 30 | | | 16 | | | | 273 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 832 | 375 | 228 | 22 | 375 | 0 | 190 | 158 | 0 | 38 | 33 | 163 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Detector Phase | 1 | 6 | 6 | 5 | 2 | | 3 | 8 | | 7 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 10.0 | 10.0 | 4.0 | 10.0 | | 4.0 | 10.0 | | 4.0 | 10.0 | 10.0 |

# Lanes, Volumes, Timings
## 69: Canal Rd & Scenic Hwy/Meetinghouse Ln

02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 17.0 | 17.0 | 11.0 | 17.0 | | 11.0 | 17.0 | | 11.0 | 17.0 | 17.0 |
| Total Split (s) | 18.0 | 24.0 | 24.0 | 15.0 | 21.0 | | 40.0 | 46.0 | | 15.0 | 21.0 | 21.0 |
| Total Split (%) | 18.0% | 24.0% | 24.0% | 15.0% | 21.0% | | 40.0% | 46.0% | | 15.0% | 21.0% | 21.0% |
| Maximum Green (s) | 11.0 | 17.0 | 17.0 | 8.0 | 14.0 | | 33.0 | 39.0 | | 8.0 | 14.0 | 14.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | Lag | Lag | Lead | Lag | | Lead | Lag | | Lead | Lag | Lag |
| Lead-Lag Optimize? | Yes | Yes | Yes | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | None | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 52.9 | 47.3 | 47.3 | 20.2 | 14.0 | | 16.1 | 24.2 | | 7.1 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.53 | 0.47 | 0.47 | 0.20 | 0.14 | | 0.16 | 0.24 | | 0.07 | 0.10 | 0.10 |
| v/c Ratio | 1.28 | 0.43 | 0.26 | 0.09 | 1.39 | | 0.67 | 0.35 | | 0.30 | 0.18 | 0.40 |
| Control Delay | 163.1 | 22.3 | 2.2 | 18.1 | 228.3 | | 50.4 | 31.6 | | 50.2 | 43.8 | 3.0 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 163.1 | 22.3 | 2.2 | 18.1 | 228.3 | | 50.4 | 31.6 | | 50.2 | 43.8 | 3.0 |
| LOS | F | C | A | B | F | | D | C | | D | D | A |
| Approach Delay | | 100.8 | | | 216.7 | | | 41.8 | | | 16.4 | |
| Approach LOS | | F | | | F | | | D | | | B | |
| Queue Length 50th (ft) | ~621 | 134 | 0 | 6 | ~305 | | 115 | 81 | | 23 | 20 | 0 |
| Queue Length 95th (ft) | #930 | 298 | 29 | 21 | #488 | | 175 | 134 | | 56 | 49 | 0 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 650 | 882 | 893 | 282 | 270 | | 584 | 713 | | 141 | 260 | 456 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.28 | 0.43 | 0.26 | 0.08 | 1.39 | | 0.33 | 0.22 | | 0.27 | 0.13 | 0.36 |

Intersection Summary

Area Type: Other

Cycle Length: 100

Actuated Cycle Length: 100

Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green

Natural Cycle: 140

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.39

Intersection Signal Delay: 103.2 Intersection LOS: F

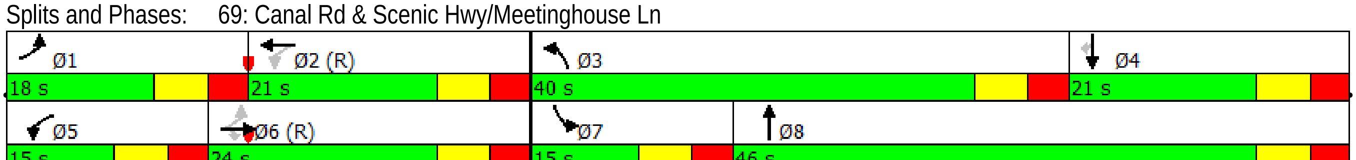
Intersection Capacity Utilization 103.1% ICU Level of Service G

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.94 | | 1.00 | 0.97 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | | 1770 | 1804 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.22 | 1.00 | 1.00 | 0.54 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 409 | 1863 | 1583 | 1003 | 1745 | | 1770 | 1804 | | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| RTOR Reduction (vph) | 0 | 0 | 136 | 0 | 27 | 0 | 0 | 12 | 0 | 0 | 0 | 142 |
| Lane Group Flow (vph) | 832 | 375 | 92 | 22 | 348 | 0 | 190 | 146 | 0 | 38 | 33 | 21 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Actuated Green, G (s) | 50.1 | 40.4 | 40.4 | 13.9 | 11.2 | | 16.1 | 24.2 | | 4.7 | 12.8 | 12.8 |
| Effective Green, g (s) | 50.1 | 40.4 | 40.4 | 13.9 | 11.2 | | 16.1 | 24.2 | | 4.7 | 12.8 | 12.8 |
| Actuated g/C Ratio | 0.50 | 0.40 | 0.40 | 0.14 | 0.11 | | 0.16 | 0.24 | | 0.05 | 0.13 | 0.13 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 639 | 752 | 639 | 160 | 195 | | 284 | 436 | | 83 | 238 | 202 |
| v/s Ratio Prot | c0.42 | 0.20 | | 0.00 | c0.20 | | c0.11 | c0.08 | | 0.02 | 0.02 | |
| v/s Ratio Perm | 0.24 | | 0.06 | 0.02 | | | | | | | | 0.01 |
| v/c Ratio | 1.30 | 0.50 | 0.14 | 0.14 | 1.79 | | 0.67 | 0.33 | | 0.46 | 0.14 | 0.10 |
| Uniform Delay, d1 | 26.1 | 22.2 | 18.9 | 37.5 | 44.4 | | 39.4 | 31.3 | | 46.4 | 38.7 | 38.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 147.1 | 2.4 | 0.5 | 0.4 | 373.8 | | 5.9 | 0.5 | | 4.0 | 0.3 | 0.2 |
| Delay (s) | 173.3 | 24.6 | 19.3 | 37.9 | 418.2 | | 45.3 | 31.7 | | 50.4 | 39.0 | 38.8 |
| Level of Service | F | C | B | D | F | | D | C | | D | D | D |
| Approach Delay (s) | | 110.0 | | | 397.1 | | | 39.1 | | | 40.7 | |
| Approach LOS | | F | | | F | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 140.3 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.09 | | |
| Actuated Cycle Length (s) | 100.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 103.1% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (veh/h) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 0 | 38 | 33 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 479 | 882 | 749 | 381 | 383 | 279 | 228 | 375 | 0 | 48 | 185 | 158 |
| Arrive On Green | 0.11 | 0.47 | 0.47 | 0.02 | 0.38 | 0.38 | 0.13 | 0.20 | 0.00 | 0.03 | 0.10 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 1774 | 1003 | 731 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Grp Volume(v), veh/h | 832 | 375 | 228 | 22 | 0 | 375 | 190 | 125 | 0 | 38 | 33 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 1774 | 0 | 1734 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Q Serve(g_s), s | 11.0 | 13.3 | 8.9 | 0.8 | 0.0 | 17.1 | 10.4 | 5.7 | 0.0 | 2.1 | 1.6 | 0.0 |
| Cycle Q Clear(g_c), s | 11.0 | 13.3 | 8.9 | 0.8 | 0.0 | 17.1 | 10.4 | 5.7 | 0.0 | 2.1 | 1.6 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.42 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 479 | 882 | 749 | 381 | 0 | 662 | 228 | 375 | 0 | 48 | 185 | 158 |
| V/C Ratio(X) | 1.74 | 0.43 | 0.30 | 0.06 | 0.00 | 0.57 | 0.83 | 0.33 | 0.00 | 0.79 | 0.18 | 0.00 |
| Avail Cap(c_a), veh/h | 479 | 882 | 749 | 491 | 0 | 662 | 585 | 726 | 0 | 142 | 261 | 222 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 26.7 | 17.4 | 16.2 | 18.3 | 0.0 | 24.4 | 42.5 | 34.2 | 0.0 | 48.4 | 41.3 | 0.0 |
| Incr Delay (d2), s/veh | 340.5 | 1.5 | 1.0 | 0.1 | 0.0 | 3.5 | 7.6 | 0.5 | 0.0 | 24.6 | 0.5 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 53.1 | 7.1 | 4.1 | 0.4 | 0.0 | 8.8 | 5.6 | 3.0 | 0.0 | 1.4 | 0.9 | 0.0 |
| LnGrp Delay(d),s/veh | 367.2 | 18.9 | 17.2 | 18.4 | 0.0 | 27.9 | 50.1 | 34.7 | 0.0 | 72.9 | 41.7 | 0.0 |
| LnGrp LOS | F | B | B | B | | C | D | C | | E | D | |
| Approach Vol, veh/h | | 1435 | | | 397 | | | 315 | | | 71 | |
| Approach Delay, s/veh | | 220.6 | | | 27.4 | | | 44.0 | | | 58.4 | |
| Approach LOS | | F | | | C | | | D | | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | 18.0 | 45.2 | 19.9 | 17.0 | 8.8 | 54.3 | 9.7 | 27.1 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Max Green Setting (Gmax), s | 11.0 | 14.0 | 33.0 | 14.0 | 8.0 | 17.0 | 8.0 | 39.0 |
| Max Q Clear Time (g_c+I1), s | 13.0 | 19.1 | 12.4 | 3.6 | 2.8 | 15.3 | 4.1 | 7.7 |
| Green Ext Time (p_c), s | 0.0 | 0.0 | 0.5 | 0.5 | 0.0 | 1.0 | 0.0 | 0.9 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 155.7 |
| HCM 2010 LOS | F |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.937 | | | 0.969 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | 0 | 1770 | 1805 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.111 | | | 0.539 | | | 0.950 | | | 0.657 | | |
| Satd. Flow (perm) | 207 | 1863 | 1583 | 1004 | 1745 | 0 | 1770 | 1805 | 0 | 1224 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 228 | | 24 | | | 9 | | | | 163 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 832 | 375 | 228 | 22 | 375 | 0 | 190 | 158 | 0 | 38 | 33 | 163 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 2 | 2 | | 3 | 8 | | 4 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | | 4.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 17.0 | 17.0 | 17.0 | 17.0 | | 11.0 | 17.0 | | 17.0 | 17.0 | 17.0 |
| Total Split (s) | 65.0 | 101.0 | 101.0 | 36.0 | 36.0 | | 22.0 | 39.0 | | 17.0 | 17.0 | 17.0 |
| Total Split (%) | 46.4% | 72.1% | 72.1% | 25.7% | 25.7% | | 15.7% | 27.9% | | 12.1% | 12.1% | 12.1% |
| Maximum Green (s) | 58.0 | 94.0 | 94.0 | 29.0 | 29.0 | | 15.0 | 32.0 | | 10.0 | 10.0 | 10.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | C-Max | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 94.0 | 94.0 | 94.0 | 29.0 | 29.0 | | 15.0 | 32.0 | | 10.0 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.67 | 0.67 | 0.67 | 0.21 | 0.21 | | 0.11 | 0.23 | | 0.07 | 0.07 | 0.07 |
| v/c Ratio | 1.06 | 0.30 | 0.20 | 0.11 | 0.99 | | 1.01 | 0.38 | | 0.44 | 0.25 | 0.62 |
| Control Delay | 82.7 | 10.2 | 1.4 | 46.8 | 94.3 | | 128.1 | 46.0 | | 78.4 | 66.4 | 19.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 82.7 | 10.2 | 1.4 | 46.8 | 94.3 | | 128.1 | 46.0 | | 78.4 | 66.4 | 19.5 |
| LOS | F | B | A | D | F | | F | D | | E | E | B |
| Approach Delay | | 50.8 | | | 91.7 | | | 90.8 | | | 35.7 | |
| Approach LOS | | D | | | F | | | F | | | D | |
| Queue Length 50th (ft) | ~779 | 130 | 0 | 16 | 325 | | ~176 | 115 | | 34 | 29 | 0 |
| Queue Length 95th (ft) | #1035 | 181 | 27 | 42 | #538 | | #340 | 186 | | 74 | 66 | 72 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 786 | 1250 | 1137 | 207 | 380 | | 189 | 419 | | 87 | 133 | 264 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.06 | 0.30 | 0.20 | 0.11 | 0.99 | | 1.01 | 0.38 | | 0.44 | 0.25 | 0.62 |

Intersection Summary

Area Type: Other

Cycle Length: 140

Actuated Cycle Length: 140

Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green

Natural Cycle: 140

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 1.06

Intersection Signal Delay: 61.9 Intersection LOS: E

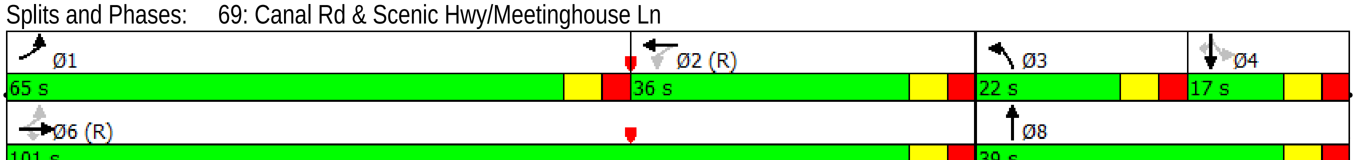
Intersection Capacity Utilization 103.1% ICU Level of Service G

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (vph) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.94 | | 1.00 | 0.97 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1745 | | 1770 | 1804 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.11 | 1.00 | 1.00 | 0.54 | 1.00 | | 0.95 | 1.00 | | 0.66 | 1.00 | 1.00 |
| Satd. Flow (perm) | 207 | 1863 | 1583 | 1003 | 1745 | | 1770 | 1804 | | 1223 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 33 | 38 | 33 | 163 |
| RTOR Reduction (vph) | 0 | 0 | 75 | 0 | 19 | 0 | 0 | 7 | 0 | 0 | 0 | 151 |
| Lane Group Flow (vph) | 832 | 375 | 153 | 22 | 356 | 0 | 190 | 151 | 0 | 38 | 33 | 12 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | 4 | | 4 |
| Actuated Green, G (s) | 94.0 | 94.0 | 94.0 | 29.0 | 29.0 | | 15.0 | 32.0 | | 10.0 | 10.0 | 10.0 |
| Effective Green, g (s) | 94.0 | 94.0 | 94.0 | 29.0 | 29.0 | | 15.0 | 32.0 | | 10.0 | 10.0 | 10.0 |
| Actuated g/C Ratio | 0.67 | 0.67 | 0.67 | 0.21 | 0.21 | | 0.11 | 0.23 | | 0.07 | 0.07 | 0.07 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 786 | 1250 | 1062 | 207 | 361 | | 189 | 412 | | 87 | 133 | 113 |
| v/s Ratio Prot | c0.44 | 0.20 | | | 0.20 | | c0.11 | c0.08 | | | 0.02 | |
| v/s Ratio Perm | c0.27 | | 0.10 | 0.02 | | | | | | 0.03 | | 0.01 |
| v/c Ratio | 1.06 | 0.30 | 0.14 | 0.11 | 0.99 | | 1.01 | 0.37 | | 0.44 | 0.25 | 0.10 |
| Uniform Delay, d1 | 35.7 | 9.5 | 8.4 | 45.0 | 55.3 | | 62.5 | 45.5 | | 62.3 | 61.4 | 60.8 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 48.7 | 0.6 | 0.3 | 1.0 | 44.0 | | 66.8 | 0.6 | | 3.5 | 1.0 | 0.4 |
| Delay (s) | 84.4 | 10.1 | 8.7 | 46.0 | 99.3 | | 129.3 | 46.0 | | 65.8 | 62.4 | 61.2 |
| Level of Service | F | B | A | D | F | | F | D | | E | E | E |
| Approach Delay (s) | | 52.9 | | | 96.4 | | | 91.5 | | | 62.1 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 66.5 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 1.03 | | |
| Actuated Cycle Length (s) | 140.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 103.1% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Signalized Intersection Summary
69: Canal Rd & Scenic Hwy/Meetinghouse Ln 02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Future Volume (veh/h) | 765 | 345 | 210 | 20 | 200 | 145 | 175 | 115 | 30 | 35 | 30 | 150 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 832 | 375 | 228 | 22 | 217 | 158 | 190 | 125 | 0 | 38 | 33 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 786 | 1251 | 1063 | 220 | 208 | 151 | 190 | 426 | 0 | 141 | 133 | 113 |
| Arrive On Green | 0.41 | 0.67 | 0.67 | 0.21 | 0.21 | 0.21 | 0.11 | 0.23 | 0.00 | 0.07 | 0.07 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 813 | 1003 | 731 | 1774 | 1863 | 0 | 1261 | 1863 | 1583 |
| Grp Volume(v), veh/h | 832 | 375 | 228 | 22 | 0 | 375 | 190 | 125 | 0 | 38 | 33 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 813 | 0 | 1734 | 1774 | 1863 | 0 | 1261 | 1863 | 1583 |
| Q Serve(g_s), s | 58.0 | 11.6 | 7.7 | 3.1 | 0.0 | 29.0 | 15.0 | 7.8 | 0.0 | 4.0 | 2.3 | 0.0 |
| Cycle Q Clear(g_c), s | 58.0 | 11.6 | 7.7 | 3.1 | 0.0 | 29.0 | 15.0 | 7.8 | 0.0 | 4.0 | 2.3 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.42 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 786 | 1251 | 1063 | 220 | 0 | 359 | 190 | 426 | 0 | 141 | 133 | 113 |
| V/C Ratio(X) | 1.06 | 0.30 | 0.21 | 0.10 | 0.00 | 1.04 | 1.00 | 0.29 | 0.00 | 0.27 | 0.25 | 0.00 |
| Avail Cap(c_a), veh/h | 786 | 1251 | 1063 | 220 | 0 | 359 | 190 | 426 | 0 | 141 | 133 | 113 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 35.8 | 9.5 | 8.8 | 45.2 | 0.0 | 55.5 | 62.5 | 44.7 | 0.0 | 62.2 | 61.5 | 0.0 |
| Incr Delay (d2), s/veh | 48.5 | 0.6 | 0.5 | 0.9 | 0.0 | 59.4 | 65.2 | 0.4 | 0.0 | 1.0 | 1.0 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 41.0 | 6.2 | 3.5 | 0.8 | 0.0 | 19.8 | 10.8 | 4.0 | 0.0 | 1.5 | 1.2 | 0.0 |
| LnGrp Delay(d),s/veh | 84.3 | 10.1 | 9.3 | 46.1 | 0.0 | 114.9 | 127.7 | 45.0 | 0.0 | 63.2 | 62.4 | 0.0 |
| LnGrp LOS | F | B | A | D | | F | F | D | | E | E | |
| Approach Vol, veh/h | | 1435 | | | 397 | | | 315 | | | 71 | |
| Approach Delay, s/veh | | 53.0 | | | 111.1 | | | 94.9 | | | 62.9 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 65.0 | 36.0 | 22.0 | 17.0 | | 101.0 | | 39.0 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | | 7.0 |
| Max Green Setting (Gmax), s | 58.0 | 29.0 | 15.0 | 10.0 | | 94.0 | | 32.0 |
| Max Q Clear Time (g_c+I1), s | 60.0 | 31.0 | 17.0 | 6.0 | | 13.6 | | 9.8 |
| Green Ext Time (p_c), s | 0.0 | 0.0 | 0.0 | 0.3 | | 7.0 | | 0.9 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 69.7 |
| HCM 2010 LOS | E |

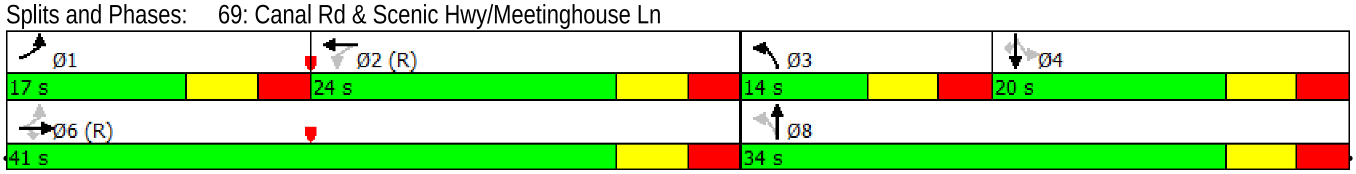
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Future Volume (vph) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.947 | | | 0.957 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1764 | 0 | 1770 | 1783 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.281 | | | 0.518 | | | 0.420 | | | 0.586 | | |
| Satd. Flow (perm) | 523 | 1863 | 1583 | 965 | 1764 | 0 | 782 | 1783 | 0 | 1092 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 266 | | 34 | | | 31 | | | | 462 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 185 | 418 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 462 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 185 | 418 | 266 | 38 | 337 | 0 | 250 | 283 | 0 | 87 | 109 | 462 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | pm+pt | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 2 | 2 | | 3 | 8 | | 4 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 23.0 | 23.0 | 23.0 | 23.0 | | 11.0 | 23.0 | | 11.0 | 11.0 | 11.0 |
| Total Split (s) | 17.0 | 41.0 | 41.0 | 24.0 | 24.0 | | 14.0 | 34.0 | | 20.0 | 20.0 | 20.0 |
| Total Split (%) | 22.7% | 54.7% | 54.7% | 32.0% | 32.0% | | 18.7% | 45.3% | | 26.7% | 26.7% | 26.7% |
| Maximum Green (s) | 10.0 | 34.0 | 34.0 | 17.0 | 17.0 | | 7.0 | 27.0 | | 13.0 | 13.0 | 13.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | C-Max | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 36.0 | 36.0 | 36.0 | 19.0 | 19.0 | | 25.0 | 25.0 | | 11.0 | 11.0 | 11.0 |
| Actuated g/C Ratio | 0.48 | 0.48 | 0.48 | 0.25 | 0.25 | | 0.33 | 0.33 | | 0.15 | 0.15 | 0.15 |
| v/c Ratio | 0.44 | 0.47 | 0.30 | 0.16 | 0.71 | | 0.71 | 0.46 | | 0.54 | 0.40 | 0.74 |
| Control Delay | 15.7 | 15.9 | 2.7 | 25.3 | 34.2 | | 31.9 | 19.6 | | 42.0 | 32.7 | 11.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 15.7 | 15.9 | 2.7 | 25.3 | 34.2 | | 31.9 | 19.6 | | 42.0 | 32.7 | 11.1 |
| LOS | B | B | A | C | C | | C | B | | D | C | B |
| Approach Delay | | 11.8 | | | 33.3 | | | 25.4 | | | 18.8 | |
| Approach LOS | | B | | | C | | | C | | | B | |
| Queue Length 50th (ft) | 50 | 131 | 0 | 14 | 134 | | 85 | 86 | | 37 | 45 | 0 |
| Queue Length 95th (ft) | 90 | 208 | 38 | 39 | #262 | | #152 | 151 | | 81 | 90 | 81 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 417 | 894 | 898 | 244 | 472 | | 352 | 661 | | 189 | 322 | 656 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.44 | 0.47 | 0.30 | 0.16 | 0.71 | | 0.71 | 0.43 | | 0.46 | 0.34 | 0.70 |

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 75
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 65
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 20.0 Intersection LOS: B
Intersection Capacity Utilization 73.8% ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Future Volume (vph) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.95 | | 1.00 | 0.96 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1763 | | 1770 | 1782 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.28 | 1.00 | 1.00 | 0.52 | 1.00 | | 0.42 | 1.00 | | 0.59 | 1.00 | 1.00 |
| Satd. Flow (perm) | 524 | 1863 | 1583 | 965 | 1763 | | 782 | 1782 | | 1092 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 185 | 418 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 462 |
| RTOR Reduction (vph) | 0 | 0 | 138 | 0 | 25 | 0 | 0 | 21 | 0 | 0 | 0 | 394 |
| Lane Group Flow (vph) | 185 | 418 | 128 | 38 | 312 | 0 | 250 | 262 | 0 | 87 | 109 | 68 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | pm+pt | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Actuated Green, G (s) | 36.0 | 36.0 | 36.0 | 19.0 | 19.0 | | 25.0 | 25.0 | | 11.0 | 11.0 | 11.0 |
| Effective Green, g (s) | 36.0 | 36.0 | 36.0 | 19.0 | 19.0 | | 25.0 | 25.0 | | 11.0 | 11.0 | 11.0 |
| Actuated g/C Ratio | 0.48 | 0.48 | 0.48 | 0.25 | 0.25 | | 0.33 | 0.33 | | 0.15 | 0.15 | 0.15 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 417 | 894 | 759 | 244 | 446 | | 352 | 594 | | 160 | 273 | 232 |
| v/s Ratio Prot | 0.06 | c0.22 | | | c0.18 | | c0.07 | 0.15 | | | 0.06 | |
| v/s Ratio Perm | 0.15 | | 0.08 | 0.04 | | | c0.17 | | | 0.08 | | 0.04 |
| v/c Ratio | 0.44 | 0.47 | 0.17 | 0.16 | 0.70 | | 0.71 | 0.44 | | 0.54 | 0.40 | 0.29 |
| Uniform Delay, d1 | 12.7 | 13.1 | 11.0 | 21.8 | 25.4 | | 20.7 | 19.5 | | 29.7 | 29.0 | 28.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 1.8 | 0.5 | 1.4 | 8.8 | | 6.6 | 0.5 | | 3.7 | 1.0 | 0.7 |
| Delay (s) | 13.4 | 14.8 | 11.5 | 23.1 | 34.2 | | 27.3 | 20.1 | | 33.4 | 30.0 | 29.2 |
| Level of Service | B | B | B | C | C | | C | C | | C | C | C |
| Approach Delay (s) | | 13.5 | | | 33.1 | | | 23.5 | | | 29.9 | |
| Approach LOS | | B | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 23.1 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 73.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Future Volume (veh/h) | 170 | 385 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 425 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 185 | 418 | 266 | 38 | 217 | 120 | 250 | 201 | 0 | 87 | 109 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 455 | 960 | 816 | 316 | 329 | 182 | 333 | 555 | 0 | 227 | 207 | 176 |
| Arrive On Green | 0.13 | 0.52 | 0.52 | 0.29 | 0.29 | 0.29 | 0.09 | 0.30 | 0.00 | 0.11 | 0.11 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 754 | 1129 | 624 | 1774 | 1863 | 0 | 1177 | 1863 | 1583 |
| Grp Volume(v), veh/h | 185 | 418 | 266 | 38 | 0 | 337 | 250 | 201 | 0 | 87 | 109 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 754 | 0 | 1753 | 1774 | 1863 | 0 | 1177 | 1863 | 1583 |
| Q Serve(g_s), s | 4.8 | 10.5 | 7.3 | 2.8 | 0.0 | 12.6 | 7.0 | 6.4 | 0.0 | 5.3 | 4.1 | 0.0 |
| Cycle Q Clear(g_c), s | 4.8 | 10.5 | 7.3 | 2.8 | 0.0 | 12.6 | 7.0 | 6.4 | 0.0 | 5.3 | 4.1 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.36 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 455 | 960 | 816 | 316 | 0 | 511 | 333 | 555 | 0 | 227 | 207 | 176 |
| V/C Ratio(X) | 0.41 | 0.44 | 0.33 | 0.12 | 0.00 | 0.66 | 0.75 | 0.36 | 0.00 | 0.38 | 0.53 | 0.00 |
| Avail Cap(c_a), veh/h | 460 | 960 | 816 | 316 | 0 | 511 | 333 | 671 | 0 | 300 | 323 | 274 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 14.5 | 11.4 | 10.6 | 19.8 | 0.0 | 23.3 | 27.7 | 20.7 | 0.0 | 32.0 | 31.5 | 0.0 |
| Incr Delay (d2), s/veh | 0.6 | 1.4 | 1.1 | 0.8 | 0.0 | 6.5 | 9.1 | 0.4 | 0.0 | 1.1 | 2.1 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 2.4 | 5.7 | 3.4 | 0.6 | 0.0 | 7.0 | 5.2 | 3.3 | 0.0 | 1.8 | 2.2 | 0.0 |
| LnGrp Delay(d),s/veh | 15.0 | 12.8 | 11.6 | 20.6 | 0.0 | 29.8 | 36.9 | 21.1 | 0.0 | 33.0 | 33.5 | 0.0 |
| LnGrp LOS | B | B | B | C | | C | D | C | | C | C | |
| Approach Vol, veh/h | | 869 | | | 375 | | | 451 | | | 196 | |
| Approach Delay, s/veh | | 12.9 | | | 28.9 | | | 29.8 | | | 33.3 | |
| Approach LOS | | B | | | C | | | C | | | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 16.8 | 28.9 | 14.0 | 15.3 | | 45.7 | | 29.3 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | | 7.0 |
| Max Green Setting (Gmax), s | 10.0 | 17.0 | 7.0 | 13.0 | | 34.0 | | 27.0 |
| Max Q Clear Time (g_c+I1), s | 6.8 | 14.6 | 9.0 | 7.3 | | 12.5 | | 8.4 |
| Green Ext Time (p_c), s | 0.1 | 1.4 | 0.0 | 1.0 | | 6.3 | | 2.0 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 22.2 |
| HCM 2010 LOS | C |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Future Volume (vph) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.960 | | | 0.955 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1788 | 0 | 1770 | 1779 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.499 | | | 0.575 | | | 0.481 | | | 0.610 | | |
| Satd. Flow (perm) | 930 | 1863 | 1583 | 1071 | 1788 | 0 | 896 | 1779 | 0 | 1136 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 227 | | 14 | | | 20 | | | | 467 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 207 | 304 | 223 | 33 | 163 | 60 | 212 | 168 | 71 | 49 | 92 | 467 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 207 | 304 | 223 | 33 | 223 | 0 | 212 | 239 | 0 | 49 | 92 | 467 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | | pm+pt | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 5 | 2 | | 3 | 8 | | 7 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |

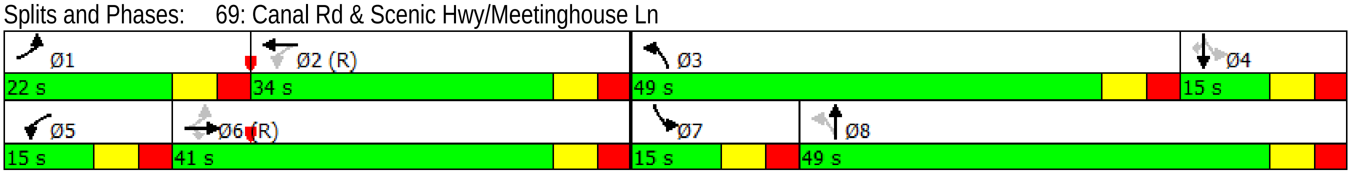
Lanes, Volumes, Timings
69: Canal Rd & Scenic Hwy/Meetinghouse Ln 02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 23.0 | 23.0 | 11.0 | 23.0 | | 11.0 | 23.0 | | 11.0 | 11.0 | 11.0 |
| Total Split (s) | 22.0 | 41.0 | 41.0 | 15.0 | 34.0 | | 49.0 | 49.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (%) | 18.3% | 34.2% | 34.2% | 12.5% | 28.3% | | 40.8% | 40.8% | | 12.5% | 12.5% | 12.5% |
| Maximum Green (s) | 15.0 | 34.0 | 34.0 | 8.0 | 27.0 | | 42.0 | 42.0 | | 8.0 | 8.0 | 8.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | Lag | Lag | Lead | Lag | | Lead | Lag | | Lead | Lag | Lag |
| Lead-Lag Optimize? | Yes | Yes | Yes | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | None | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 68.0 | 59.7 | 59.7 | 54.6 | 48.0 | | 37.8 | 26.1 | | 21.5 | 14.2 | 14.2 |
| Actuated g/C Ratio | 0.57 | 0.50 | 0.50 | 0.46 | 0.40 | | 0.32 | 0.22 | | 0.18 | 0.12 | 0.12 |
| v/c Ratio | 0.33 | 0.33 | 0.25 | 0.06 | 0.31 | | 0.53 | 0.60 | | 0.20 | 0.42 | 0.78 |
| Control Delay | 16.2 | 23.3 | 4.0 | 15.9 | 28.0 | | 35.3 | 44.5 | | 28.9 | 53.0 | 13.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 16.2 | 23.3 | 4.0 | 15.9 | 28.0 | | 35.3 | 44.5 | | 28.9 | 53.0 | 13.9 |
| LOS | B | C | A | B | C | | D | D | | C | D | B |
| Approach Delay | | 15.4 | | | 26.4 | | | 40.2 | | | 21.0 | |
| Approach LOS | | B | | | C | | | D | | | C | |
| Queue Length 50th (ft) | 73 | 147 | 0 | 11 | 106 | | 129 | 161 | | 27 | 68 | 0 |
| Queue Length 95th (ft) | 149 | 274 | 52 | 33 | 220 | | 165 | 214 | | 47 | 110 | 99 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 639 | 926 | 901 | 546 | 722 | | 632 | 635 | | 252 | 221 | 599 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.32 | 0.33 | 0.25 | 0.06 | 0.31 | | 0.34 | 0.38 | | 0.19 | 0.42 | 0.78 |

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 75
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.78
Intersection Signal Delay: 23.9 Intersection LOS: C
Intersection Capacity Utilization 66.2% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Future Volume (vph) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.96 | | 1.00 | 0.96 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1788 | | 1770 | 1780 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.50 | 1.00 | 1.00 | 0.57 | 1.00 | | 0.48 | 1.00 | | 0.61 | 1.00 | 1.00 |
| Satd. Flow (perm) | 930 | 1863 | 1583 | 1071 | 1788 | | 897 | 1780 | | 1136 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 207 | 304 | 223 | 33 | 163 | 60 | 212 | 168 | 71 | 49 | 92 | 467 |
| RTOR Reduction (vph) | 0 | 0 | 120 | 0 | 9 | 0 | 0 | 16 | 0 | 0 | 0 | 406 |
| Lane Group Flow (vph) | 207 | 304 | 103 | 33 | 214 | 0 | 212 | 223 | 0 | 49 | 92 | 61 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | | pm+pt | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Actuated Green, G (s) | 66.8 | 55.5 | 55.5 | 50.9 | 46.6 | | 39.2 | 26.1 | | 21.7 | 15.6 | 15.6 |
| Effective Green, g (s) | 66.8 | 55.5 | 55.5 | 50.9 | 46.6 | | 39.2 | 26.1 | | 21.7 | 15.6 | 15.6 |
| Actuated g/C Ratio | 0.56 | 0.46 | 0.46 | 0.42 | 0.39 | | 0.33 | 0.22 | | 0.18 | 0.13 | 0.13 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 610 | 861 | 732 | 479 | 694 | | 413 | 387 | | 237 | 242 | 205 |
| v/s Ratio Prot | c0.04 | c0.16 | | 0.00 | 0.12 | | c0.07 | c0.13 | | 0.01 | 0.05 | |
| v/s Ratio Perm | 0.15 | | 0.07 | 0.03 | | | 0.10 | | | 0.03 | | 0.04 |
| v/c Ratio | 0.34 | 0.35 | 0.14 | 0.07 | 0.31 | | 0.51 | 0.58 | | 0.21 | 0.38 | 0.30 |
| Uniform Delay, d1 | 13.9 | 20.7 | 18.5 | 20.3 | 25.5 | | 31.1 | 42.0 | | 41.4 | 47.8 | 47.2 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 1.1 | 0.4 | 0.1 | 1.2 | | 1.1 | 2.1 | | 0.4 | 1.0 | 0.8 |
| Delay (s) | 14.2 | 21.9 | 18.9 | 20.3 | 26.7 | | 32.2 | 44.1 | | 41.8 | 48.8 | 48.0 |
| Level of Service | B | C | B | C | C | | C | D | | D | D | D |
| Approach Delay (s) | | 18.8 | | | 25.8 | | | 38.5 | | | 47.7 | |
| Approach LOS | | B | | | C | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 32.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 66.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Future Volume (veh/h) | 190 | 280 | 205 | 30 | 150 | 55 | 195 | 155 | 65 | 45 | 85 | 430 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 207 | 304 | 223 | 33 | 163 | 60 | 212 | 168 | 0 | 49 | 92 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 687 | 1025 | 871 | 503 | 636 | 234 | 310 | 298 | 0 | 200 | 122 | 104 |
| Arrive On Green | 0.08 | 0.55 | 0.55 | 0.02 | 0.49 | 0.49 | 0.13 | 0.16 | 0.00 | 0.03 | 0.07 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 1774 | 1300 | 478 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Grp Volume(v), veh/h | 207 | 304 | 223 | 33 | 0 | 223 | 212 | 168 | 0 | 49 | 92 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 1774 | 0 | 1778 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Q Serve(g_s), s | 6.5 | 10.5 | 8.8 | 1.1 | 0.0 | 8.8 | 12.9 | 10.0 | 0.0 | 3.1 | 5.8 | 0.0 |
| Cycle Q Clear(g_c), s | 6.5 | 10.5 | 8.8 | 1.1 | 0.0 | 8.8 | 12.9 | 10.0 | 0.0 | 3.1 | 5.8 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.27 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 687 | 1025 | 871 | 503 | 0 | 870 | 310 | 298 | 0 | 200 | 122 | 104 |
| V/C Ratio(X) | 0.30 | 0.30 | 0.26 | 0.07 | 0.00 | 0.26 | 0.68 | 0.56 | 0.00 | 0.25 | 0.75 | 0.00 |
| Avail Cap(c_a), veh/h | 762 | 1025 | 871 | 582 | 0 | 870 | 703 | 652 | 0 | 258 | 124 | 106 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 12.1 | 14.5 | 14.1 | 14.6 | 0.0 | 17.9 | 42.7 | 46.5 | 0.0 | 50.0 | 55.1 | 0.0 |
| Incr Delay (d2), s/veh | 0.2 | 0.7 | 0.7 | 0.1 | 0.0 | 0.7 | 2.7 | 1.7 | 0.0 | 0.6 | 22.4 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 3.2 | 5.6 | 4.0 | 0.5 | 0.0 | 4.4 | 6.5 | 5.3 | 0.0 | 1.5 | 3.7 | 0.0 |
| LnGrp Delay(d),s/veh | 12.3 | 15.2 | 14.8 | 14.7 | 0.0 | 18.6 | 45.4 | 48.2 | 0.0 | 50.7 | 77.6 | 0.0 |
| LnGrp LOS | B | B | B | B | | B | D | D | | D | E | |
| Approach Vol, veh/h | | 734 | | | 256 | | | 380 | | | 141 | |
| Approach Delay, s/veh | | 14.3 | | | 18.1 | | | 46.6 | | | 68.2 | |
| Approach LOS | | B | | | B | | | D | | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | 17.0 | 65.7 | 22.4 | 14.9 | 9.7 | 73.0 | 11.1 | 26.2 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Max Green Setting (Gmax), s | 15.0 | 27.0 | 42.0 | 8.0 | 8.0 | 34.0 | 8.0 | 42.0 |
| Max Q Clear Time (g_c+I1), s | 8.5 | 10.8 | 14.9 | 7.8 | 3.1 | 12.5 | 5.1 | 12.0 |
| Green Ext Time (p_c), s | 0.3 | 3.7 | 0.6 | 0.0 | 0.0 | 4.0 | 0.0 | 1.5 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 28.1 |
| HCM 2010 LOS | C |

# Lanes, Volumes, Timings
## 69: Canal Rd & Scenic Hwy/Meetinghouse Ln

02/14/2018

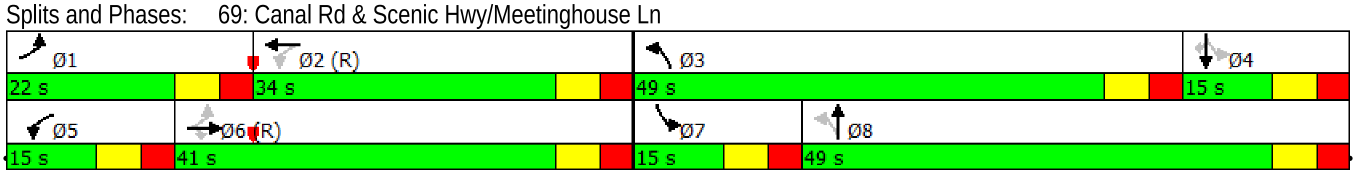
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.947 | | | 0.957 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1764 | 0 | 1770 | 1783 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.372 | | | 0.486 | | | 0.466 | | | 0.586 | | |
| Satd. Flow (perm) | 693 | 1863 | 1583 | 905 | 1764 | 0 | 868 | 1783 | 0 | 1092 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 266 | | 21 | | | 19 | | | | 418 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 418 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 212 | 408 | 266 | 38 | 337 | 0 | 250 | 283 | 0 | 87 | 109 | 418 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | | pm+pt | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 5 | 2 | | 3 | 8 | | 7 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 23.0 | 23.0 | 11.0 | 23.0 | | 11.0 | 23.0 | | 11.0 | 11.0 | 11.0 |
| Total Split (s) | 22.0 | 41.0 | 41.0 | 15.0 | 34.0 | | 49.0 | 49.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (%) | 18.3% | 34.2% | 34.2% | 12.5% | 28.3% | | 40.8% | 40.8% | | 12.5% | 12.5% | 12.5% |
| Maximum Green (s) | 15.0 | 34.0 | 34.0 | 8.0 | 27.0 | | 42.0 | 42.0 | | 8.0 | 8.0 | 8.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | Lag | Lag | Lead | Lag | | Lead | Lag | | Lead | Lag | Lag |
| Lead-Lag Optimize? | Yes | Yes | Yes | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | None | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 65.4 | 56.9 | 56.9 | 51.7 | 44.9 | | 40.3 | 25.7 | | 22.5 | 14.8 | 14.8 |
| Actuated g/C Ratio | 0.54 | 0.47 | 0.47 | 0.43 | 0.37 | | 0.34 | 0.21 | | 0.19 | 0.12 | 0.12 |
| v/c Ratio | 0.42 | 0.46 | 0.30 | 0.09 | 0.50 | | 0.58 | 0.71 | | 0.35 | 0.47 | 0.75 |
| Control Delay | 18.5 | 27.2 | 4.2 | 16.9 | 33.3 | | 35.2 | 50.1 | | 31.3 | 54.8 | 13.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 18.5 | 27.2 | 4.2 | 16.9 | 33.3 | | 35.2 | 50.1 | | 31.3 | 54.8 | 13.2 |
| LOS | B | C | A | B | C | | D | D | | C | D | B |
| Approach Delay | | 18.2 | | | 31.6 | | | 43.1 | | | 23.2 | |
| Approach LOS | | B | | | C | | | D | | | C | |
| Queue Length 50th (ft) | 81 | 226 | 0 | 13 | 185 | | 148 | 191 | | 47 | 80 | 0 |
| Queue Length 95th (ft) | 154 | 386 | 59 | 37 | #368 | | 192 | 257 | | 74 | 131 | 95 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 521 | 883 | 890 | 458 | 673 | | 635 | 636 | | 252 | 230 | 561 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.41 | 0.46 | 0.30 | 0.08 | 0.50 | | 0.39 | 0.44 | | 0.35 | 0.47 | 0.75 |

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 75
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.75
Intersection Signal Delay: 27.1 Intersection LOS: C
Intersection Capacity Utilization 71.3% ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



# HCM Signalized Intersection Capacity Analysis
## 69: Canal Rd & Scenic Hwy/Meetinghouse Ln

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | ↰ | ↑ | ↱ | ↰ | ↑↱ | | ↰ | ↑↱ | | ↰ | ↑ | ↱ |
| Traffic Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.95 | | 1.00 | 0.96 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1763 | | 1770 | 1782 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.37 | 1.00 | 1.00 | 0.49 | 1.00 | | 0.47 | 1.00 | | 0.59 | 1.00 | 1.00 |
| Satd. Flow (perm) | 693 | 1863 | 1583 | 906 | 1763 | | 868 | 1782 | | 1092 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 418 |
| RTOR Reduction (vph) | 0 | 0 | 146 | 0 | 13 | 0 | 0 | 15 | 0 | 0 | 0 | 366 |
| Lane Group Flow (vph) | 212 | 408 | 120 | 38 | 324 | 0 | 250 | 268 | 0 | 87 | 109 | 52 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | | pm+pt | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Actuated Green, G (s) | 65.6 | 54.1 | 54.1 | 49.4 | 44.9 | | 40.4 | 25.7 | | 22.5 | 14.8 | 14.8 |
| Effective Green, g (s) | 65.6 | 54.1 | 54.1 | 49.4 | 44.9 | | 40.4 | 25.7 | | 22.5 | 14.8 | 14.8 |
| Actuated g/C Ratio | 0.55 | 0.45 | 0.45 | 0.41 | 0.37 | | 0.34 | 0.21 | | 0.19 | 0.12 | 0.12 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 501 | 839 | 713 | 405 | 659 | | 432 | 381 | | 248 | 229 | 195 |
| v/s Ratio Prot | c0.05 | c0.22 | | 0.00 | 0.18 | | c0.09 | c0.15 | | 0.02 | 0.06 | |
| v/s Ratio Perm | 0.18 | | 0.08 | 0.04 | | | 0.11 | | | 0.04 | | 0.03 |
| v/c Ratio | 0.42 | 0.49 | 0.17 | 0.09 | 0.49 | | 0.58 | 0.70 | | 0.35 | 0.48 | 0.26 |
| Uniform Delay, d1 | 15.6 | 23.2 | 19.6 | 21.3 | 28.8 | | 31.0 | 43.6 | | 41.7 | 49.0 | 47.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.0 | 0.5 | 0.1 | 2.6 | | 1.9 | 5.8 | | 0.9 | 1.6 | 0.7 |
| Delay (s) | 16.2 | 25.2 | 20.1 | 21.4 | 31.4 | | 32.9 | 49.4 | | 42.5 | 50.5 | 48.4 |
| Level of Service | B | C | C | C | C | | C | D | | D | D | D |
| Approach Delay (s) | | 21.5 | | | 30.4 | | | 41.7 | | | 47.9 | |
| Approach LOS | | C | | | C | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 34.1 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.60 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 71.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (veh/h) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 0 | 87 | 109 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 563 | 982 | 835 | 403 | 528 | 292 | 335 | 292 | 0 | 228 | 124 | 106 |
| Arrive On Green | 0.08 | 0.53 | 0.53 | 0.02 | 0.47 | 0.47 | 0.15 | 0.16 | 0.00 | 0.06 | 0.07 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 1774 | 1129 | 624 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Grp Volume(v), veh/h | 212 | 408 | 266 | 38 | 0 | 337 | 250 | 201 | 0 | 87 | 109 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 1774 | 0 | 1753 | 1774 | 1863 | 0 | 1774 | 1863 | 1583 |
| Q Serve(g_s), s | 7.0 | 15.9 | 11.5 | 1.3 | 0.0 | 15.2 | 15.1 | 12.2 | 0.0 | 5.4 | 7.0 | 0.0 |
| Cycle Q Clear(g_c), s | 7.0 | 15.9 | 11.5 | 1.3 | 0.0 | 15.2 | 15.1 | 12.2 | 0.0 | 5.4 | 7.0 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.36 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 563 | 982 | 835 | 403 | 0 | 820 | 335 | 292 | 0 | 228 | 124 | 106 |
| V/C Ratio(X) | 0.38 | 0.42 | 0.32 | 0.09 | 0.00 | 0.41 | 0.75 | 0.69 | 0.00 | 0.38 | 0.88 | 0.00 |
| Avail Cap(c_a), veh/h | 637 | 982 | 835 | 479 | 0 | 820 | 692 | 652 | 0 | 243 | 124 | 106 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 14.3 | 17.2 | 16.1 | 16.2 | 0.0 | 21.0 | 41.6 | 47.8 | 0.0 | 48.3 | 55.5 | 0.0 |
| Incr Delay (d2), s/veh | 0.4 | 1.3 | 1.0 | 0.1 | 0.0 | 1.5 | 3.3 | 2.9 | 0.0 | 1.0 | 45.9 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 3.4 | 8.5 | 5.2 | 0.7 | 0.0 | 7.6 | 7.7 | 6.5 | 0.0 | 2.7 | 5.2 | 0.0 |
| LnGrp Delay(d),s/veh | 14.7 | 18.5 | 17.1 | 16.3 | 0.0 | 22.5 | 44.9 | 50.7 | 0.0 | 49.3 | 101.4 | 0.0 |
| LnGrp LOS | B | B | B | B | | C | D | D | | D | F | |
| Approach Vol, veh/h | | 886 | | | 375 | | | 451 | | | 196 | |
| Approach Delay, s/veh | | 17.1 | | | 21.9 | | | 47.5 | | | 78.3 | |
| Approach LOS | | B | | | C | | | D | | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | 17.0 | 63.2 | 24.8 | 15.0 | 9.9 | 70.3 | 14.0 | 25.8 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Max Green Setting (Gmax), s | 15.0 | 27.0 | 42.0 | 8.0 | 8.0 | 34.0 | 8.0 | 42.0 |
| Max Q Clear Time (g_c+I1), s | 9.0 | 17.2 | 17.1 | 9.0 | 3.3 | 17.9 | 7.4 | 14.2 |
| Green Ext Time (p_c), s | 0.3 | 4.0 | 0.7 | 0.0 | 0.0 | 5.3 | 0.0 | 1.8 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 31.5 |
| HCM 2010 LOS | | C |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.947 | | | 0.957 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1764 | 0 | 1770 | 1783 | 0 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.293 | | | 0.523 | | | 0.407 | | | 0.586 | | |
| Satd. Flow (perm) | 546 | 1863 | 1583 | 974 | 1764 | 0 | 758 | 1783 | 0 | 1092 | 1863 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 266 | | 35 | | | 30 | | | | 418 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 418 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 212 | 408 | 266 | 38 | 337 | 0 | 250 | 283 | 0 | 87 | 109 | 418 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | pm+pt | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Detector Phase | 1 | 6 | 6 | 2 | 2 | | 3 | 8 | | 4 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |

## Lanes, Volumes, Timings
## 69: Canal Rd & Scenic Hwy/Meetinghouse Ln

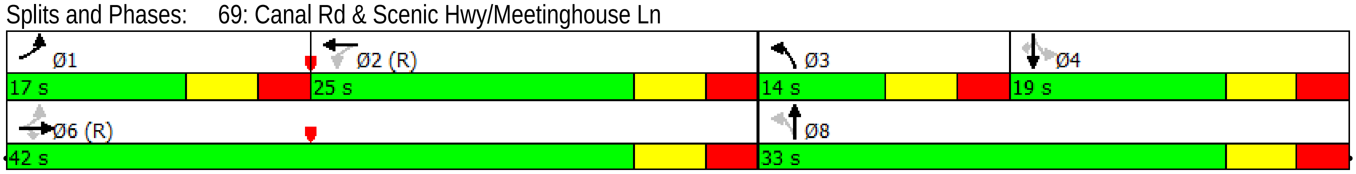
02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 23.0 | 23.0 | 23.0 | 23.0 | | 11.0 | 23.0 | | 11.0 | 11.0 | 11.0 |
| Total Split (s) | 17.0 | 42.0 | 42.0 | 25.0 | 25.0 | | 14.0 | 33.0 | | 19.0 | 19.0 | 19.0 |
| Total Split (%) | 22.7% | 56.0% | 56.0% | 33.3% | 33.3% | | 18.7% | 44.0% | | 25.3% | 25.3% | 25.3% |
| Maximum Green (s) | 10.0 | 35.0 | 35.0 | 18.0 | 18.0 | | 7.0 | 26.0 | | 12.0 | 12.0 | 12.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | C-Max | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 36.8 | 36.8 | 36.8 | 19.8 | 19.8 | | 24.2 | 24.2 | | 10.2 | 10.2 | 10.2 |
| Actuated g/C Ratio | 0.49 | 0.49 | 0.49 | 0.26 | 0.26 | | 0.32 | 0.32 | | 0.14 | 0.14 | 0.14 |
| v/c Ratio | 0.49 | 0.45 | 0.29 | 0.15 | 0.69 | | 0.74 | 0.48 | | 0.59 | 0.43 | 0.73 |
| Control Delay | 15.9 | 15.0 | 2.6 | 24.3 | 31.9 | | 35.0 | 20.6 | | 46.2 | 34.5 | 11.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 15.9 | 15.0 | 2.6 | 24.3 | 31.9 | | 35.0 | 20.6 | | 46.2 | 34.5 | 11.5 |
| LOS | B | B | A | C | C | | C | C | | D | C | B |
| Approach Delay | | 11.5 | | | 31.1 | | | 27.3 | | | 20.5 | |
| Approach LOS | | B | | | C | | | C | | | C | |
| Queue Length 50th (ft) | 57 | 123 | 0 | 14 | 130 | | 87 | 88 | | 37 | 46 | 0 |
| Queue Length 95th (ft) | 100 | 196 | 37 | 38 | #250 | | #165 | 155 | | 82 | 91 | 78 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 431 | 913 | 911 | 256 | 490 | | 339 | 637 | | 174 | 298 | 604 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.49 | 0.45 | 0.29 | 0.15 | 0.69 | | 0.74 | 0.44 | | 0.50 | 0.37 | 0.69 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 75 | |
| Actuated Cycle Length: 75 | |
| Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green | |
| Natural Cycle: 65 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.74 | |
| Intersection Signal Delay: 20.4 | Intersection LOS: C |
| Intersection Capacity Utilization 71.3% | ICU Level of Service C |
| Analysis Period (min) 15 | |

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (vph) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.95 | | 1.00 | 0.96 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1763 | | 1770 | 1782 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.29 | 1.00 | 1.00 | 0.52 | 1.00 | | 0.41 | 1.00 | | 0.59 | 1.00 | 1.00 |
| Satd. Flow (perm) | 546 | 1863 | 1583 | 974 | 1763 | | 759 | 1782 | | 1092 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 82 | 87 | 109 | 418 |
| RTOR Reduction (vph) | 0 | 0 | 135 | 0 | 26 | 0 | 0 | 20 | 0 | 0 | 0 | 361 |
| Lane Group Flow (vph) | 212 | 408 | 131 | 38 | 311 | 0 | 250 | 263 | 0 | 87 | 109 | 57 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | | pm+pt | NA | | Perm | NA | Perm |
| Protected Phases | 1 | 6 | | | 2 | | 3 | 8 | | | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | 8 | | | 4 | | 4 |
| Actuated Green, G (s) | 36.8 | 36.8 | 36.8 | 19.8 | 19.8 | | 24.2 | 24.2 | | 10.2 | 10.2 | 10.2 |
| Effective Green, g (s) | 36.8 | 36.8 | 36.8 | 19.8 | 19.8 | | 24.2 | 24.2 | | 10.2 | 10.2 | 10.2 |
| Actuated g/C Ratio | 0.49 | 0.49 | 0.49 | 0.26 | 0.26 | | 0.32 | 0.32 | | 0.14 | 0.14 | 0.14 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 431 | 914 | 776 | 257 | 465 | | 339 | 574 | | 148 | 253 | 215 |
| v/s Ratio Prot | 0.07 | c0.22 | | | c0.18 | | c0.07 | 0.15 | | | 0.06 | |
| v/s Ratio Perm | 0.18 | | 0.08 | 0.04 | | | c0.17 | | | 0.08 | | 0.04 |
| v/c Ratio | 0.49 | 0.45 | 0.17 | 0.15 | 0.67 | | 0.74 | 0.46 | | 0.59 | 0.43 | 0.26 |
| Uniform Delay, d1 | 12.4 | 12.5 | 10.6 | 21.1 | 24.7 | | 21.4 | 20.2 | | 30.4 | 29.7 | 29.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.9 | 1.6 | 0.5 | 1.2 | 7.5 | | 8.1 | 0.6 | | 5.9 | 1.2 | 0.7 |
| Delay (s) | 13.3 | 14.0 | 11.1 | 22.4 | 32.1 | | 29.6 | 20.8 | | 36.3 | 30.9 | 29.7 |
| Level of Service | B | B | B | C | C | | C | C | | D | C | C |
| Approach Delay (s) | | 13.0 | | | 31.1 | | | 24.9 | | | 30.8 | |
| Approach LOS | | B | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 23.0 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.76 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 71.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Future Volume (veh/h) | 195 | 375 | 245 | 35 | 200 | 110 | 230 | 185 | 75 | 80 | 100 | 385 |
| Number | 1 | 6 | 16 | 5 | 2 | 12 | 3 | 8 | 18 | 7 | 4 | 14 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1863 | 1863 | 1863 | 1863 | 1863 | 1900 | 1863 | 1863 | 1900 | 1863 | 1863 | 1863 |
| Adj Flow Rate, veh/h | 212 | 408 | 266 | 38 | 217 | 120 | 250 | 201 | 0 | 87 | 109 | 0 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cap, veh/h | 458 | 963 | 819 | 318 | 330 | 182 | 331 | 552 | 0 | 225 | 204 | 173 |
| Arrive On Green | 0.13 | 0.52 | 0.52 | 0.29 | 0.29 | 0.29 | 0.09 | 0.30 | 0.00 | 0.11 | 0.11 | 0.00 |
| Sat Flow, veh/h | 1774 | 1863 | 1583 | 761 | 1129 | 624 | 1774 | 1863 | 0 | 1177 | 1863 | 1583 |
| Grp Volume(v), veh/h | 212 | 408 | 266 | 38 | 0 | 337 | 250 | 201 | 0 | 87 | 109 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1774 | 1863 | 1583 | 761 | 0 | 1753 | 1774 | 1863 | 0 | 1177 | 1863 | 1583 |
| Q Serve(g_s), s | 5.6 | 10.2 | 7.3 | 2.8 | 0.0 | 12.6 | 7.0 | 6.4 | 0.0 | 5.3 | 4.2 | 0.0 |
| Cycle Q Clear(g_c), s | 5.6 | 10.2 | 7.3 | 2.8 | 0.0 | 12.6 | 7.0 | 6.4 | 0.0 | 5.3 | 4.2 | 0.0 |
| Prop In Lane | 1.00 | | 1.00 | 1.00 | | 0.36 | 1.00 | | 0.00 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 458 | 963 | 819 | 318 | 0 | 512 | 331 | 552 | 0 | 225 | 204 | 173 |
| V/C Ratio(X) | 0.46 | 0.42 | 0.32 | 0.12 | 0.00 | 0.66 | 0.76 | 0.36 | 0.00 | 0.39 | 0.53 | 0.00 |
| Avail Cap(c_a), veh/h | 461 | 963 | 819 | 318 | 0 | 512 | 331 | 646 | 0 | 284 | 298 | 253 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 14.7 | 11.2 | 10.5 | 19.8 | 0.0 | 23.3 | 27.9 | 20.8 | 0.0 | 32.1 | 31.6 | 0.0 |
| Incr Delay (d2), s/veh | 0.7 | 1.4 | 1.1 | 0.8 | 0.0 | 6.5 | 9.5 | 0.4 | 0.0 | 1.1 | 2.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 2.7 | 5.6 | 3.4 | 0.6 | 0.0 | 7.0 | 5.3 | 3.4 | 0.0 | 1.8 | 2.2 | 0.0 |
| LnGrp Delay(d),s/veh | 15.4 | 12.6 | 11.6 | 20.5 | 0.0 | 29.8 | 37.4 | 21.2 | 0.0 | 33.2 | 33.8 | 0.0 |
| LnGrp LOS | B | B | B | C | | C | D | C | | C | C | |
| Approach Vol, veh/h | | 886 | | | 375 | | | 451 | | | 196 | |
| Approach Delay, s/veh | | 12.9 | | | 28.8 | | | 30.2 | | | 33.5 | |
| Approach LOS | | B | | | C | | | C | | | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | 1 | 2 | 3 | 4 | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | 16.9 | 28.9 | 14.0 | 15.2 | | 45.8 | | 29.2 |
| Change Period (Y+Rc), s | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | | 7.0 |
| Max Green Setting (Gmax), s | 10.0 | 18.0 | 7.0 | 12.0 | | 35.0 | | 26.0 |
| Max Q Clear Time (g_c+I1), s | 7.6 | 14.6 | 9.0 | 7.3 | | 12.2 | | 8.4 |
| Green Ext Time (p_c), s | 0.1 | 1.9 | 0.0 | 0.9 | | 6.3 | | 1.9 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 22.3 |
| HCM 2010 LOS | | C |

| Lane Group | EBL | EBT | EBR | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1255 | 25 | 325 | 1305 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1255 | 25 | 325 | 1305 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.997 | | 0.879 | | | | 0.850 | | | | 0.850 |
| Flt Protected | | 0.997 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3417 | 0 | 3022 | 0 | 0 | 1719 | 1538 | 0 | 0 | 1719 | 1538 |
| Flt Permitted | | 0.566 | | | | | 0.729 | | | | 0.732 | |
| Satd. Flow (perm) | 0 | 1940 | 0 | 3022 | 0 | 0 | 1319 | 1538 | 0 | 0 | 1325 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | |
| Satd. Flow (RTOR) | | 5 | | 7 | | | | 115 | | | | |
| Link Speed (mph) | | 30 | | 30 | | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | 584 | | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | 13.3 | | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1364 | 27 | 353 | 1418 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1494 | 0 | 1836 | 0 | 0 | 49 | 38 | 0 | 0 | 43 | 76 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Right | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | 0 | | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | 0 | | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | 16 | | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | | 9 | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 2 | | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Thru | | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 100 | | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 6 | | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | 94 | | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | 6 | | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | Cl+Ex | | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | 0.0 | | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | NA | | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | 8 | | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | | | | 2 | | | 6 | | 6 |
| Detector Phase | 7 | 4 | | 8 | | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 4.0 | 40.0 | | 40.0 | | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

## Lanes, Volumes, Timings
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

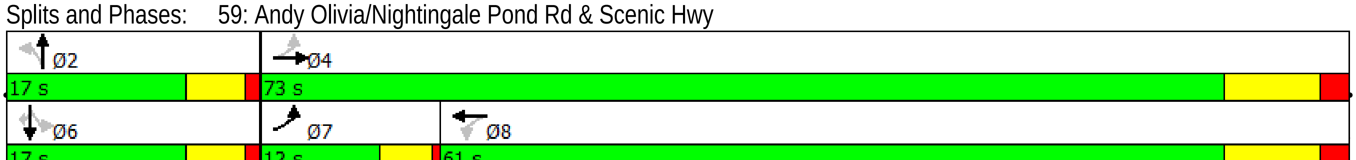
02/14/2018

| Lane Group | EBL | EBT | EBR | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 8.0 | 48.5 | | 48.5 | | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 12.0 | 73.0 | | 61.0 | | | 17.0 | 17.0 | | 17.0 | 17.0 | 17.0 |
| Total Split (%) | 13.3% | 81.1% | | 67.8% | | | 18.9% | 18.9% | | 18.9% | 18.9% | 18.9% |
| Maximum Green (s) | 8.0 | 64.5 | | 52.5 | | | 12.0 | 12.0 | | 12.0 | 12.0 | 12.0 |
| Yellow Time (s) | 3.5 | 6.5 | | 6.5 | | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 0.5 | 2.0 | | 2.0 | | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | 0.0 | | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | 8.5 | | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | Lead | | | Lag | | | | | | | | |
| Lead-Lag Optimize? | Yes | | | Yes | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | Min | | Min | | | None | None | | None | None | None |
| Act Effct Green (s) | | 69.3 | | 69.3 | | | 10.7 | 10.7 | | | 10.7 | 10.7 |
| Actuated g/C Ratio | | 0.78 | | 0.78 | | | 0.12 | 0.12 | | | 0.12 | 0.12 |
| v/c Ratio | | 0.99 | | 1.21dr | | | 0.31 | 0.13 | | | 0.27 | 0.41 |
| Control Delay | | 34.5 | | 10.7 | | | 41.3 | 1.0 | | | 40.1 | 43.4 |
| Queue Delay | | 0.0 | | 0.0 | | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 34.5 | | 10.7 | | | 41.3 | 1.0 | | | 40.1 | 43.4 |
| LOS | | C | | B | | | D | A | | | D | D |
| Approach Delay | | 34.5 | | 10.7 | | | | 23.7 | | | 42.2 | |
| Approach LOS | | C | | B | | | | C | | | D | |
| Queue Length 50th (ft) | | ~481 | | 298 | | | 25 | 0 | | | 22 | 40 |
| Queue Length 95th (ft) | | #639 | | 456 | | | 60 | 0 | | | 54 | 83 |
| Internal Link Dist (ft) | | 306 | | 504 | | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1516 | | 2361 | | | 178 | 307 | | | 179 | 208 |
| Starvation Cap Reductn | | 0 | | 0 | | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | 0 | | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | 0 | | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 0.99 | | 0.78 | | | 0.28 | 0.12 | | | 0.24 | 0.37 |

**Intersection Summary**

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 88.7
Natural Cycle: 130
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.99
Intersection Signal Delay: 22.1 Intersection LOS: C
Intersection Capacity Utilization 118.9% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



# HCM Signalized Intersection Capacity Analysis
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Movement | EBL | EBT | EBR | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1255 | 25 | 325 | 1305 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1255 | 25 | 325 | 1305 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | 8.5 | | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | 0.95 | | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 1.00 | | 0.88 | | | 1.00 | 0.85 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | 1.00 | | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3417 | | 3022 | | | 1719 | 1538 | | | 1719 | 1538 |
| Flt Permitted | | 0.57 | | 1.00 | | | 0.73 | 1.00 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | | 1940 | | 3022 | | | 1319 | 1538 | | | 1325 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1364 | 27 | 353 | 1418 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 1493 | 0 | 1834 | 0 | 0 | 49 | 4 | 0 | 0 | 43 | 76 |
| Turn Type | pm+pt | NA | | NA | | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | 8 | | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 67.5 | | 67.5 | | | 8.6 | 8.6 | | | 8.6 | 8.6 |
| Effective Green, g (s) | | 67.5 | | 67.5 | | | 8.6 | 8.6 | | | 8.6 | 8.6 |
| Actuated g/C Ratio | | 0.75 | | 0.75 | | | 0.10 | 0.10 | | | 0.10 | 0.10 |
| Clearance Time (s) | | 8.5 | | 8.5 | | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | 3.0 | | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1461 | | 2276 | | | 126 | 147 | | | 127 | 147 |
| v/s Ratio Prot | | | | 0.61 | | | | 0.00 | | | | |
| v/s Ratio Perm | | c0.77 | | | | | 0.04 | | | | 0.03 | c0.05 |
| v/c Ratio | | 1.02 | | 1.21dr | | | 0.39 | 0.02 | | | 0.34 | 0.52 |
| Uniform Delay, d1 | | 11.0 | | 6.9 | | | 38.0 | 36.7 | | | 37.8 | 38.5 |
| Progression Factor | | 1.00 | | 1.00 | | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 29.2 | | 2.2 | | | 2.0 | 0.1 | | | 1.6 | 3.1 |
| Delay (s) | | 40.2 | | 9.1 | | | 40.0 | 36.8 | | | 39.4 | 41.6 |
| Level of Service | | D | | A | | | D | D | | | D | D |
| Approach Delay (s) | | 40.2 | | 9.1 | | | | 38.6 | | | 40.8 | |
| Approach LOS | | D | | A | | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 24.1 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 1.02 | | |
| Actuated Cycle Length (s) | 89.6 | Sum of lost time (s) | 17.5 |
| Intersection Capacity Utilization | 118.9% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group

HCM 2010 methodology does not support more than 4 approaches.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 55 | 875 | 20 | 0 | 1200 | 25 | 15 | 0 | 0 | 10 | 0 | 35 |
| Future Volume (vph) | 55 | 875 | 20 | 0 | 1200 | 25 | 15 | 0 | 0 | 10 | 0 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.997 | | | 0.997 | | | | | | | 0.850 |
| Flt Protected | | 0.997 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3518 | 0 | 0 | 3529 | 0 | 1770 | 1863 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.773 | | | | | 0.750 | | | | 0.757 | |
| Satd. Flow (perm) | 0 | 2728 | 0 | 0 | 3529 | 0 | 1397 | 1863 | 0 | 0 | 1410 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 5 | | | 5 | | | | | | | 75 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 951 | 22 | 0 | 1304 | 27 | 16 | 0 | 0 | 11 | 0 | 38 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1033 | 0 | 0 | 1331 | 0 | 16 | 0 | 0 | 0 | 11 | 38 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Perm | NA | | | NA | | Perm | | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 4 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 40.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

# Lanes, Volumes, Timings
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

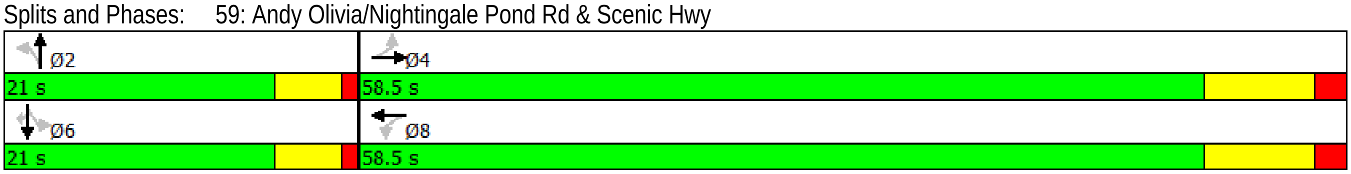
02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 48.5 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 58.5 | 58.5 | | 58.5 | 58.5 | | 21.0 | 21.0 | | 21.0 | 21.0 | 21.0 |
| Total Split (%) | 73.6% | 73.6% | | 73.6% | 73.6% | | 26.4% | 26.4% | | 26.4% | 26.4% | 26.4% |
| Maximum Green (s) | 50.0 | 50.0 | | 50.0 | 50.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | 16.0 |
| Yellow Time (s) | 6.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 50.1 | | | 50.1 | | 10.0 | | | | 10.0 | 10.0 |
| Actuated g/C Ratio | | 0.78 | | | 0.78 | | 0.16 | | | | 0.16 | 0.16 |
| v/c Ratio | | 0.48 | | | 0.48 | | 0.07 | | | | 0.05 | 0.12 |
| Control Delay | | 6.0 | | | 5.6 | | 24.7 | | | | 24.3 | 3.3 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | | | | 0.0 | 0.0 |
| Total Delay | | 6.0 | | | 5.6 | | 24.7 | | | | 24.3 | 3.3 |
| LOS | | A | | | A | | C | | | | C | A |
| Approach Delay | | 6.0 | | | 5.6 | | | 24.7 | | | 8.0 | |
| Approach LOS | | A | | | A | | | C | | | A | |
| Queue Length 50th (ft) | | 105 | | | 135 | | 5 | | | | 4 | 0 |
| Queue Length 95th (ft) | | 153 | | | 185 | | 21 | | | | 17 | 10 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 2361 | | | 3053 | | 349 | | | | 352 | 451 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | | | | 0 | 0 |
| Reduced v/c Ratio | | 0.44 | | | 0.44 | | 0.05 | | | | 0.03 | 0.08 |

**Intersection Summary**

Area Type: Other
Cycle Length: 79.5
Actuated Cycle Length: 64.1
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.48
Intersection Signal Delay: 5.9 Intersection LOS: A
Intersection Capacity Utilization 85.8% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



# HCM Signalized Intersection Capacity Analysis
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 55 | 875 | 20 | 0 | 1200 | 25 | 15 | 0 | 0 | 10 | 0 | 35 |
| Future Volume (vph) | 55 | 875 | 20 | 0 | 1200 | 25 | 15 | 0 | 0 | 10 | 0 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | | | | 1.00 | 1.00 |
| Frt | | 1.00 | | | 1.00 | | 1.00 | | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3518 | | | 3528 | | 1770 | | | | 1770 | 1583 |
| Flt Permitted | | 0.77 | | | 1.00 | | 0.75 | | | | 0.76 | 1.00 |
| Satd. Flow (perm) | | 2728 | | | 3528 | | 1398 | | | | 1410 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 951 | 22 | 0 | 1304 | 27 | 16 | 0 | 0 | 11 | 0 | 38 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| Lane Group Flow (vph) | 0 | 1032 | 0 | 0 | 1330 | 0 | 16 | 0 | 0 | 0 | 11 | 3 |
| Turn Type | Perm | NA | | | NA | | Perm | | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 46.7 | | | 46.7 | | 6.0 | | | | 6.0 | 6.0 |
| Effective Green, g (s) | | 46.7 | | | 46.7 | | 6.0 | | | | 6.0 | 6.0 |
| Actuated g/C Ratio | | 0.71 | | | 0.71 | | 0.09 | | | | 0.09 | 0.09 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1924 | | | 2488 | | 126 | | | | 127 | 143 |
| v/s Ratio Prot | | | | | 0.38 | | | | | | | |
| v/s Ratio Perm | | c0.38 | | | | | c0.01 | | | | 0.01 | 0.00 |
| v/c Ratio | | 0.54 | | | 0.53 | | 0.13 | | | | 0.09 | 0.02 |
| Uniform Delay, d1 | | 4.6 | | | 4.6 | | 27.7 | | | | 27.6 | 27.4 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.3 | | | 0.2 | | 0.5 | | | | 0.3 | 0.1 |
| Delay (s) | | 4.9 | | | 4.8 | | 28.1 | | | | 27.9 | 27.5 |
| Level of Service | | A | | | A | | C | | | | C | C |
| Approach Delay (s) | | 4.9 | | | 4.8 | | | 28.1 | | | 27.6 | |
| Approach LOS | | A | | | A | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 5.5 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 66.2 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 85.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 analysis supports yellow change in the range of 3 and 6 seconds

# Lanes, Volumes, Timings
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.997 | | | 0.994 | | | 0.850 | | | | 0.850 |
| Flt Protected | | 0.996 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3514 | 0 | 0 | 3518 | 0 | 1770 | 1583 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.599 | | | | | 0.729 | | | | 0.732 | |
| Satd. Flow (perm) | 0 | 2114 | 0 | 0 | 3518 | 0 | 1358 | 1583 | 0 | 0 | 1364 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 5 | | | 10 | | | 78 | | | | 75 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1245 | 27 | 0 | 1565 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1375 | 0 | 0 | 1630 | 0 | 49 | 38 | 0 | 0 | 43 | 76 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Perm | NA | | | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 4 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 40.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 48.5 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 58.5 | 58.5 | | 58.5 | 58.5 | | 21.0 | 21.0 | | 21.0 | 21.0 | 21.0 |
| Total Split (%) | 73.6% | 73.6% | | 73.6% | 73.6% | | 26.4% | 26.4% | | 26.4% | 26.4% | 26.4% |
| Maximum Green (s) | 50.0 | 50.0 | | 50.0 | 50.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | 16.0 |
| Yellow Time (s) | 6.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 54.7 | | | 54.7 | | 10.2 | 10.2 | | | 10.2 | 10.2 |
| Actuated g/C Ratio | | 0.74 | | | 0.74 | | 0.14 | 0.14 | | | 0.14 | 0.14 |
| v/c Ratio | | 0.88 | | | 0.62 | | 0.26 | 0.13 | | | 0.23 | 0.27 |
| Control Delay | | 19.1 | | | 7.6 | | 32.3 | 2.9 | | | 31.6 | 10.7 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 19.1 | | | 7.6 | | 32.3 | 2.9 | | | 31.6 | 10.7 |
| LOS | | B | | | A | | C | A | | | C | B |
| Approach Delay | | 19.1 | | | 7.6 | | | 19.5 | | | 18.2 | |
| Approach LOS | | B | | | A | | | B | | | B | |
| Queue Length 50th (ft) | | 250 | | | 193 | | 20 | 0 | | | 18 | 0 |
| Queue Length 95th (ft) | | #473 | | | 275 | | 51 | 8 | | | 46 | 35 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1569 | | | 2613 | | 294 | 404 | | | 295 | 402 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 0.88 | | | 0.62 | | 0.17 | 0.09 | | | 0.15 | 0.19 |

Intersection Summary

Area Type: Other

Cycle Length: 79.5

Actuated Cycle Length: 73.7

Natural Cycle: 80

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.88

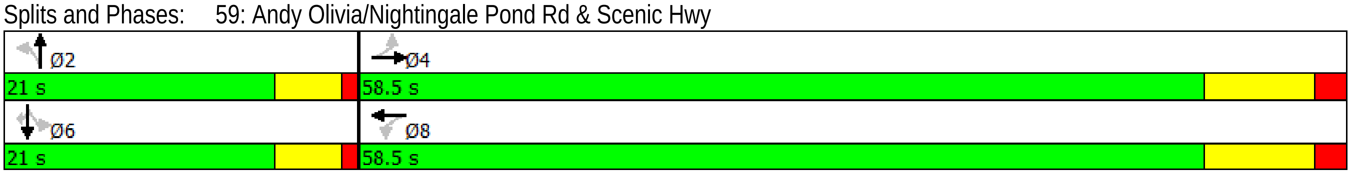
Intersection Signal Delay: 13.2 Intersection LOS: B

Intersection Capacity Utilization 104.4% ICU Level of Service G

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



# HCM Signalized Intersection Capacity Analysis
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 1.00 | | | 0.99 | | 1.00 | 0.85 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3516 | | | 3518 | | 1770 | 1583 | | | 1770 | 1583 |
| Flt Permitted | | 0.60 | | | 1.00 | | 0.73 | 1.00 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | | 2115 | | | 3518 | | 1358 | 1583 | | | 1364 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1245 | 27 | 0 | 1565 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| RTOR Reduction (vph) | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 34 | 0 | 0 | 0 | 67 |
| Lane Group Flow (vph) | 0 | 1374 | 0 | 0 | 1627 | 0 | 49 | 4 | 0 | 0 | 43 | 9 |
| Turn Type | Perm | NA | | | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 53.0 | | | 53.0 | | 8.2 | 8.2 | | | 8.2 | 8.2 |
| Effective Green, g (s) | | 53.0 | | | 53.0 | | 8.2 | 8.2 | | | 8.2 | 8.2 |
| Actuated g/C Ratio | | 0.71 | | | 0.71 | | 0.11 | 0.11 | | | 0.11 | 0.11 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1500 | | | 2496 | | 149 | 173 | | | 149 | 173 |
| v/s Ratio Prot | | | | | 0.46 | | | 0.00 | | | | |
| v/s Ratio Perm | | c0.65 | | | | | c0.04 | | | | 0.03 | 0.01 |
| v/c Ratio | | 0.92 | | | 0.65 | | 0.33 | 0.02 | | | 0.29 | 0.05 |
| Uniform Delay, d1 | | 9.0 | | | 5.9 | | 30.7 | 29.7 | | | 30.6 | 29.8 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 9.0 | | | 0.6 | | 1.3 | 0.1 | | | 1.1 | 0.1 |
| Delay (s) | | 18.0 | | | 6.5 | | 32.0 | 29.7 | | | 31.6 | 29.9 |
| Level of Service | | B | | | A | | C | C | | | C | C |
| Approach Delay (s) | | 18.0 | | | 6.5 | | | 31.0 | | | 30.5 | |
| Approach LOS | | B | | | A | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.0 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.84 | | |
| Actuated Cycle Length (s) | 74.7 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 104.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 analysis supports yellow change in the range of 3 and 6 seconds

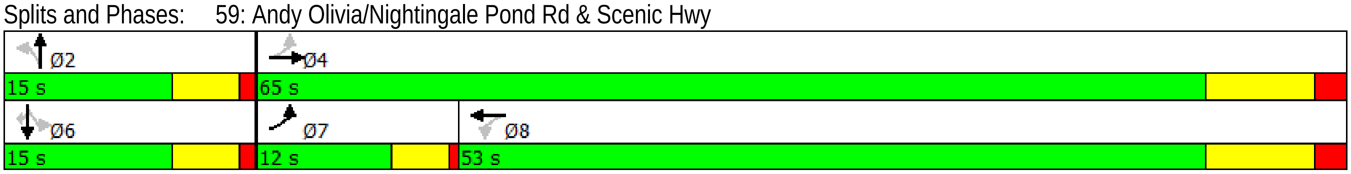
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.997 | | | 0.994 | | | 0.850 | | | | 0.850 |
| Flt Protected | | 0.996 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3514 | 0 | 0 | 3518 | 0 | 1770 | 1583 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.602 | | | | | 0.729 | | | | 0.732 | |
| Satd. Flow (perm) | 0 | 2124 | 0 | 0 | 3518 | 0 | 1358 | 1583 | 0 | 0 | 1364 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 6 | | | 8 | | | 130 | | | | 130 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1245 | 27 | 0 | 1565 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1375 | 0 | 0 | 1630 | 0 | 49 | 38 | 0 | 0 | 43 | 76 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 7 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 4.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 8.0 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 12.0 | 65.0 | | 53.0 | 53.0 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (%) | 15.0% | 81.3% | | 66.3% | 66.3% | | 18.8% | 18.8% | | 18.8% | 18.8% | 18.8% |
| Maximum Green (s) | 8.0 | 56.5 | | 44.5 | 44.5 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |
| Yellow Time (s) | 3.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 0.5 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | Lead | | | Lag | Lag | | | | | | | |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 58.7 | | | 58.7 | | 10.1 | 10.1 | | | 10.1 | 10.1 |
| Actuated g/C Ratio | | 0.77 | | | 0.77 | | 0.13 | 0.13 | | | 0.13 | 0.13 |
| v/c Ratio | | 0.85 | | | 0.61 | | 0.28 | 0.12 | | | 0.24 | 0.24 |
| Control Delay | | 15.9 | | | 6.8 | | 36.3 | 0.7 | | | 35.5 | 3.5 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 15.9 | | | 6.8 | | 36.3 | 0.7 | | | 35.5 | 3.5 |
| LOS | | B | | | A | | D | A | | | D | A |
| Approach Delay | | 15.9 | | | 6.8 | | | 20.8 | | | 15.0 | |
| Approach LOS | | B | | | A | | | C | | | B | |
| Queue Length 50th (ft) | | 248 | | | 193 | | 23 | 0 | | | 20 | 0 |
| Queue Length 95th (ft) | | #476 | | | 253 | | 55 | 0 | | | 50 | 11 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1579 | | | 2692 | | 178 | 320 | | | 179 | 320 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 0.87 | | | 0.61 | | 0.28 | 0.12 | | | 0.24 | 0.24 |

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 76.7
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.85
Intersection Signal Delay: 11.4 Intersection LOS: B
Intersection Capacity Utilization 104.4% ICU Level of Service G
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



# HCM Signalized Intersection Capacity Analysis
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Future Volume (vph) | 95 | 1145 | 25 | 0 | 1440 | 60 | 45 | 0 | 35 | 40 | 0 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 1.00 | | | 0.99 | | 1.00 | 0.85 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3516 | | | 3518 | | 1770 | 1583 | | | 1770 | 1583 |
| Flt Permitted | | 0.60 | | | 1.00 | | 0.73 | 1.00 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | | 2126 | | | 3518 | | 1358 | 1583 | | | 1364 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 103 | 1245 | 27 | 0 | 1565 | 65 | 49 | 0 | 38 | 43 | 0 | 76 |
| RTOR Reduction (vph) | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 34 | 0 | 0 | 0 | 68 |
| Lane Group Flow (vph) | 0 | 1373 | 0 | 0 | 1628 | 0 | 49 | 4 | 0 | 0 | 43 | 8 |
| Turn Type | pm+pt | NA | | | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 56.6 | | | 56.6 | | 7.7 | 7.7 | | | 7.7 | 7.7 |
| Effective Green, g (s) | | 56.6 | | | 56.6 | | 7.7 | 7.7 | | | 7.7 | 7.7 |
| Actuated g/C Ratio | | 0.73 | | | 0.73 | | 0.10 | 0.10 | | | 0.10 | 0.10 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1546 | | | 2559 | | 134 | 156 | | | 134 | 156 |
| v/s Ratio Prot | | | | | 0.46 | | | 0.00 | | | | |
| v/s Ratio Perm | | c0.65 | | | | | c0.04 | | | | 0.03 | 0.00 |
| v/c Ratio | | 0.89 | | | 0.64 | | 0.37 | 0.02 | | | 0.32 | 0.05 |
| Uniform Delay, d1 | | 8.2 | | | 5.4 | | 32.8 | 31.7 | | | 32.6 | 31.7 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 6.6 | | | 0.5 | | 1.7 | 0.1 | | | 1.4 | 0.1 |
| Delay (s) | | 14.8 | | | 5.9 | | 34.5 | 31.7 | | | 34.0 | 31.9 |
| Level of Service | | B | | | A | | C | C | | | C | C |
| Approach Delay (s) | | 14.8 | | | 5.9 | | | 33.3 | | | 32.6 | |
| Approach LOS | | B | | | A | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.88 | | |
| Actuated Cycle Length (s) | 77.8 | Sum of lost time (s) | 17.5 |
| Intersection Capacity Utilization | 104.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1290 | 85 | 5 | 935 | 755 | 25 | 85 | 5 | 80 | 5 | 0 |
| Future Volume (vph) | 100 | 1290 | 85 | 5 | 935 | 755 | 25 | 85 | 5 | 80 | 5 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.991 | | | 0.932 | | | | 0.858 | | | |
| Flt Protected | | 0.997 | | | | | | 0.950 | | | | 0.950 |
| Satd. Flow (prot) | 0 | 3397 | 0 | 0 | 3204 | 0 | 0 | 1719 | 1553 | 0 | 0 | 1719 |
| Flt Permitted | | 0.543 | | | 0.949 | | | 0.754 | | | | 0.697 |
| Satd. Flow (perm) | 0 | 1850 | 0 | 0 | 3041 | 0 | 0 | 1364 | 1553 | 0 | 0 | 1261 |
| Right Turn on Red | | | Yes | | | | Yes | | | Yes | | |
| Satd. Flow (RTOR) | | 18 | | | 3 | | | | 83 | | | |
| Link Speed (mph) | | 30 | | | 30 | | | | 30 | | | 30 |
| Link Distance (ft) | | 636 | | | 584 | | | | 567 | | | 306 |
| Travel Time (s) | | 14.5 | | | 13.3 | | | | 12.9 | | | 7.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1402 | 92 | 5 | 1016 | 821 | 27 | 92 | 5 | 87 | 5 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1603 | 0 | 0 | 1869 | 0 | 0 | 92 | 92 | 0 | 0 | 5 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Right | Left | Left | Right | Left | Left |
| Median Width(ft) | | 0 | | | 0 | | | | 12 | | | 12 |
| Link Offset(ft) | | 0 | | | 0 | | | | 0 | | | 0 |
| Crosswalk Width(ft) | | 16 | | | 16 | | | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 9 | 15 | | 9 | 15 | |
| Number of Detectors | 1 | 2 | | 1 | 2 | | | 1 | 2 | | 1 | 2 |
| Detector Template | Left | Thru | | Left | Thru | | | Left | Thru | | Left | Thru |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | | 20 | 100 | | 20 | 100 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | | 20 | 6 | | 20 | 6 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | | 94 | | | 94 |
| Detector 2 Size(ft) | | 6 | | | 6 | | | | 6 | | | 6 |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | | Cl+Ex | | | Cl+Ex |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | | 0.0 | | | 0.0 |
| Turn Type | pm+pt | NA | | Perm | NA | | | Perm | NA | | Perm | NA |
| Protected Phases | 7 | 4 | | | 8 | | | | 2 | | | 6 |
| Permitted Phases | 4 | | | 8 | | | | 2 | | | 6 | |
| Detector Phase | 7 | 4 | | 8 | 8 | | | 2 | 2 | | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 4.0 | 40.0 | | 40.0 | 40.0 | | | 10.0 | 10.0 | | 10.0 | 10.0 |

| Lane Group | SBR |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | 120 |
| Future Volume (vph) | 120 |
| Ideal Flow (vphpl) | 1900 |
| Lane Util. Factor | 1.00 |
| Frt | 0.850 |
| Flt Protected | |
| Satd. Flow (prot) | 1538 |
| Flt Permitted | |
| Satd. Flow (perm) | 1538 |
| Right Turn on Red | |
| Satd. Flow (RTOR) | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Peak Hour Factor | 0.92 |
| Adj. Flow (vph) | 130 |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | 130 |
| Enter Blocked Intersection | No |
| Lane Alignment | Right |
| Median Width(ft) | |
| Link Offset(ft) | |
| Crosswalk Width(ft) | |
| Two way Left Turn Lane | |
| Headway Factor | 1.00 |
| Turning Speed (mph) | 9 |
| Number of Detectors | 1 |
| Detector Template | Right |
| Leading Detector (ft) | 20 |
| Trailing Detector (ft) | 0 |
| Detector 1 Position(ft) | 0 |
| Detector 1 Size(ft) | 20 |
| Detector 1 Type | Cl+Ex |
| Detector 1 Channel | |
| Detector 1 Extend (s) | 0.0 |
| Detector 1 Queue (s) | 0.0 |
| Detector 1 Delay (s) | 0.0 |
| Detector 2 Position(ft) | |
| Detector 2 Size(ft) | |
| Detector 2 Type | |
| Detector 2 Channel | |
| Detector 2 Extend (s) | |
| Turn Type | Perm |
| Protected Phases | |
| Permitted Phases | 6 |
| Detector Phase | 6 |
| Switch Phase | |
| Minimum Initial (s) | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 8.0 | 48.5 | | 48.5 | 48.5 | | | 15.0 | 15.0 | | 15.0 | 15.0 |
| Total Split (s) | 12.0 | 74.0 | | 62.0 | 62.0 | | | 16.0 | 16.0 | | 16.0 | 16.0 |
| Total Split (%) | 13.3% | 82.2% | | 68.9% | 68.9% | | | 17.8% | 17.8% | | 17.8% | 17.8% |
| Maximum Green (s) | 8.0 | 65.5 | | 53.5 | 53.5 | | | 11.0 | 11.0 | | 11.0 | 11.0 |
| Yellow Time (s) | 3.5 | 6.5 | | 6.5 | 6.5 | | | 4.0 | 4.0 | | 4.0 | 4.0 |
| All-Red Time (s) | 0.5 | 2.0 | | 2.0 | 2.0 | | | 1.0 | 1.0 | | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | | | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | | 5.0 | 5.0 | | | 5.0 |
| Lead/Lag | Lead | | | Lag | Lag | | | | | | | |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 |
| Recall Mode | None | Min | | Min | Min | | | None | None | | None | None |
| Act Effct Green (s) | | 65.5 | | | 65.5 | | | 10.8 | 10.8 | | | 10.8 |
| Actuated g/C Ratio | | 0.73 | | | 0.73 | | | 0.12 | 0.12 | | | 0.12 |
| v/c Ratio | | 1.18 | | | 0.84 | | | 0.56 | 0.36 | | | 0.03 |
| Control Delay | | 107.2 | | | 13.3 | | | 51.6 | 14.6 | | | 35.6 |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | 0.0 | | | 0.0 |
| Total Delay | | 107.2 | | | 13.3 | | | 51.6 | 14.6 | | | 35.6 |
| LOS | | F | | | B | | | D | B | | | D |
| Approach Delay | | 107.2 | | | 13.3 | | | | 33.1 | | | 59.0 |
| Approach LOS | | F | | | B | | | | C | | | E |
| Queue Length 50th (ft) | | ~585 | | | 327 | | | 50 | 5 | | | 3 |
| Queue Length 95th (ft) | | #723 | | | 450 | | | #107 | 48 | | | 13 |
| Internal Link Dist (ft) | | 556 | | | 504 | | | | 487 | | | 226 |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1354 | | | 2218 | | | 166 | 262 | | | 154 |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | 0 | | | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | 0 | | | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | 0 | | | 0 |
| Reduced v/c Ratio | | 1.18 | | | 0.84 | | | 0.55 | 0.35 | | | 0.03 |

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 89.8

Natural Cycle: 140

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.18

Intersection Signal Delay: 55.6 Intersection LOS: E

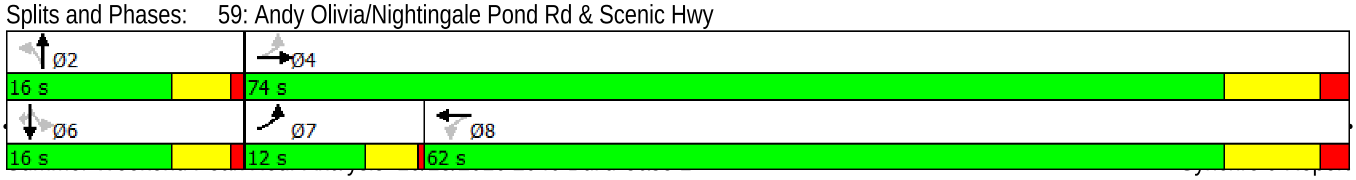
Intersection Capacity Utilization 122.0% ICU Level of Service H

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



| Lane Group | SBR |
|---|---|
| Minimum Split (s) | 15.0 |
| Total Split (s) | 16.0 |
| Total Split (%) | 17.8% |
| Maximum Green (s) | 11.0 |
| Yellow Time (s) | 4.0 |
| All-Red Time (s) | 1.0 |
| Lost Time Adjust (s) | 0.0 |
| Total Lost Time (s) | 5.0 |
| Lead/Lag | |
| Lead-Lag Optimize? | |
| Vehicle Extension (s) | 3.0 |
| Recall Mode | None |
| Act Effct Green (s) | 10.8 |
| Actuated g/C Ratio | 0.12 |
| v/c Ratio | 0.71 |
| Control Delay | 59.9 |
| Queue Delay | 0.0 |
| Total Delay | 59.9 |
| LOS | E |
| Approach Delay | |
| Approach LOS | |
| Queue Length 50th (ft) | 72 |
| Queue Length 95th (ft) | #155 |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | 188 |
| Starvation Cap Reductn | 0 |
| Spillback Cap Reductn | 0 |
| Storage Cap Reductn | 0 |
| Reduced v/c Ratio | 0.69 |

Intersection Summary

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | WBR2 | NBL2 | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1290 | 85 | 5 | 935 | 755 | 25 | 85 | 5 | 80 | 5 | 0 |
| Future Volume (vph) | 100 | 1290 | 85 | 5 | 935 | 755 | 25 | 85 | 5 | 80 | 5 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | | 5.0 | 5.0 | | | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | | 1.00 | 1.00 | | | 1.00 |
| Frt | | 0.99 | | | 0.93 | | | 1.00 | 0.86 | | | 1.00 |
| Flt Protected | | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | 0.95 |
| Satd. Flow (prot) | | 3397 | | | 3204 | | | 1719 | 1553 | | | 1719 |
| Flt Permitted | | 0.54 | | | 0.95 | | | 0.75 | 1.00 | | | 0.70 |
| Satd. Flow (perm) | | 1849 | | | 3042 | | | 1365 | 1553 | | | 1262 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1402 | 92 | 5 | 1016 | 821 | 27 | 92 | 5 | 87 | 5 | 0 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 73 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 1598 | 0 | 0 | 1868 | 0 | 0 | 92 | 19 | 0 | 0 | 5 |
| Turn Type | pm+pt | NA | | Perm | NA | | | Perm | NA | | Perm | NA |
| Protected Phases | 7 | 4 | | | 8 | | | | 2 | | | 6 |
| Permitted Phases | 4 | | | 8 | | | | 2 | | | 6 | |
| Actuated Green, G (s) | | 65.5 | | | 65.5 | | | 10.8 | 10.8 | | | 10.8 |
| Effective Green, g (s) | | 65.5 | | | 65.5 | | | 10.8 | 10.8 | | | 10.8 |
| Actuated g/C Ratio | | 0.73 | | | 0.73 | | | 0.12 | 0.12 | | | 0.12 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | | 5.0 | 5.0 | | | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | 3.0 |
| Lane Grp Cap (vph) | | 1348 | | | 2218 | | | 164 | 186 | | | 151 |
| v/s Ratio Prot | | | | | | | | | 0.01 | | | |
| v/s Ratio Perm | | c0.86 | | | 0.61 | | | 0.07 | | | | 0.00 |
| v/c Ratio | | 1.19 | | | 0.84 | | | 0.56 | 0.10 | | | 0.03 |
| Uniform Delay, d1 | | 12.1 | | | 8.5 | | | 37.3 | 35.2 | | | 34.9 |
| Progression Factor | | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | 1.00 |
| Incremental Delay, d2 | | 91.3 | | | 3.1 | | | 4.3 | 0.2 | | | 0.1 |
| Delay (s) | | 103.5 | | | 11.6 | | | 41.6 | 35.4 | | | 35.0 |
| Level of Service | | F | | | B | | | D | D | | | C |
| Approach Delay (s) | | 103.5 | | | 11.6 | | | | 38.5 | | | 49.1 |
| Approach LOS | | F | | | B | | | | D | | | D |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 53.1 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 1.18 | | |
| Actuated Cycle Length (s) | 89.8 | Sum of lost time (s) | 17.5 |
| Intersection Capacity Utilization | 122.0% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | SBR |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | 120 |
| Future Volume (vph) | 120 |
| Ideal Flow (vphpl) | 1900 |
| Total Lost time (s) | 5.0 |
| Lane Util. Factor | 1.00 |
| Frt | 0.85 |
| Flt Protected | 1.00 |
| Satd. Flow (prot) | 1538 |
| Flt Permitted | 1.00 |
| Satd. Flow (perm) | 1538 |
| Peak-hour factor, PHF | 0.92 |
| Adj. Flow (vph) | 130 |
| RTOR Reduction (vph) | 0 |
| Lane Group Flow (vph) | 130 |
| Turn Type | Perm |
| Protected Phases | |
| Permitted Phases | 6 |
| Actuated Green, G (s) | 10.8 |
| Effective Green, g (s) | 10.8 |
| Actuated g/C Ratio | 0.12 |
| Clearance Time (s) | 5.0 |
| Vehicle Extension (s) | 3.0 |
| Lane Grp Cap (vph) | 184 |
| v/s Ratio Prot | |
| v/s Ratio Perm | c0.08 |
| v/c Ratio | 0.71 |
| Uniform Delay, d1 | 38.0 |
| Progression Factor | 1.00 |
| Incremental Delay, d2 | 11.7 |
| Delay (s) | 49.7 |
| Level of Service | D |
| Approach Delay (s) | |
| Approach LOS | |

| Intersection Summary |
|---|

HCM 2010 methodology does not support more than 4 approaches.

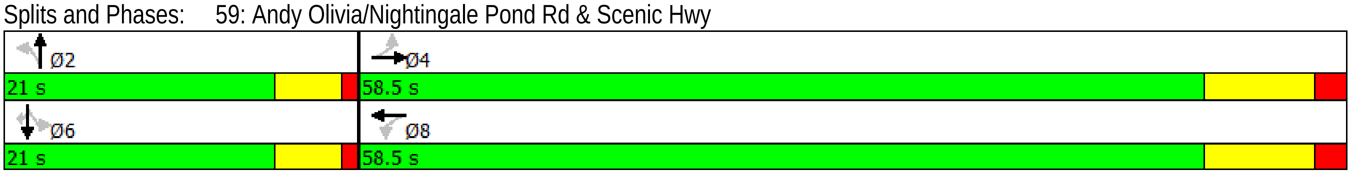
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 55 | 1075 | 70 | 5 | 1550 | 0 | 100 | 5 | 10 | 5 | 0 | 50 |
| Future Volume (vph) | 55 | 1075 | 70 | 5 | 1550 | 0 | 100 | 5 | 10 | 5 | 0 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.991 | | | | | | 0.897 | | | | 0.850 |
| Flt Protected | | 0.998 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3500 | 0 | 0 | 3539 | 0 | 1770 | 1671 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.716 | | | 0.950 | | 0.754 | | | | 0.747 | |
| Satd. Flow (perm) | 0 | 2511 | 0 | 0 | 3362 | 0 | 1405 | 1671 | 0 | 0 | 1391 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 15 | | | | | | 11 | | | | 75 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 1168 | 76 | 5 | 1685 | 0 | 109 | 5 | 11 | 5 | 0 | 54 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1304 | 0 | 0 | 1690 | 0 | 109 | 16 | 0 | 0 | 5 | 54 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 4 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 40.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 48.5 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 58.5 | 58.5 | | 58.5 | 58.5 | | 21.0 | 21.0 | | 21.0 | 21.0 | 21.0 |
| Total Split (%) | 73.6% | 73.6% | | 73.6% | 73.6% | | 26.4% | 26.4% | | 26.4% | 26.4% | 26.4% |
| Maximum Green (s) | 50.0 | 50.0 | | 50.0 | 50.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | 16.0 |
| Yellow Time (s) | 6.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 51.3 | | | 51.3 | | 11.9 | 11.9 | | | 11.9 | 11.9 |
| Actuated g/C Ratio | | 0.72 | | | 0.72 | | 0.17 | 0.17 | | | 0.17 | 0.17 |
| v/c Ratio | | 0.72 | | | 0.70 | | 0.47 | 0.06 | | | 0.02 | 0.17 |
| Control Delay | | 11.8 | | | 10.4 | | 35.1 | 17.7 | | | 26.4 | 5.5 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 11.8 | | | 10.4 | | 35.1 | 17.7 | | | 26.4 | 5.5 |
| LOS | | B | | | B | | D | B | | | C | A |
| Approach Delay | | 11.8 | | | 10.4 | | | 32.9 | | | 7.3 | |
| Approach LOS | | B | | | B | | | C | | | A | |
| Queue Length 50th (ft) | | 181 | | | 230 | | 47 | 2 | | | 2 | 0 |
| Queue Length 95th (ft) | | 335 | | | 390 | | 95 | 18 | | | 11 | 19 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1879 | | | 2511 | | 316 | 385 | | | 313 | 414 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 0.69 | | | 0.67 | | 0.34 | 0.04 | | | 0.02 | 0.13 |

Intersection Summary

Area Type: Other
Cycle Length: 79.5
Actuated Cycle Length: 71.6
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.72
Intersection Signal Delay: 11.8 Intersection LOS: B
Intersection Capacity Utilization 96.4% ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



# HCM Signalized Intersection Capacity Analysis
## 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy

02/14/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 55 | 1075 | 70 | 5 | 1550 | 0 | 100 | 5 | 10 | 5 | 0 | 50 |
| Future Volume (vph) | 55 | 1075 | 70 | 5 | 1550 | 0 | 100 | 5 | 10 | 5 | 0 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 0.99 | | | 1.00 | | 1.00 | 0.90 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3500 | | | 3539 | | 1770 | 1671 | | | 1770 | 1583 |
| Flt Permitted | | 0.72 | | | 0.95 | | 0.75 | 1.00 | | | 0.75 | 1.00 |
| Satd. Flow (perm) | | 2512 | | | 3364 | | 1405 | 1671 | | | 1392 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 1168 | 76 | 5 | 1685 | 0 | 109 | 5 | 11 | 5 | 0 | 54 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 47 |
| Lane Group Flow (vph) | 0 | 1299 | 0 | 0 | 1690 | 0 | 109 | 6 | 0 | 0 | 5 | 7 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 49.4 | | | 49.4 | | 9.7 | 9.7 | | | 9.7 | 9.7 |
| Effective Green, g (s) | | 49.4 | | | 49.4 | | 9.7 | 9.7 | | | 9.7 | 9.7 |
| Actuated g/C Ratio | | 0.68 | | | 0.68 | | 0.13 | 0.13 | | | 0.13 | 0.13 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1709 | | | 2289 | | 187 | 223 | | | 185 | 211 |
| v/s Ratio Prot | | | | | | | | 0.00 | | | | |
| v/s Ratio Perm | | c0.52 | | | 0.50 | | c0.08 | | | | 0.00 | 0.00 |
| v/c Ratio | | 0.76 | | | 0.74 | | 0.58 | 0.03 | | | 0.03 | 0.03 |
| Uniform Delay, d1 | | 7.7 | | | 7.4 | | 29.5 | 27.4 | | | 27.3 | 27.4 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.0 | | | 1.3 | | 4.6 | 0.1 | | | 0.1 | 0.1 |
| Delay (s) | | 9.7 | | | 8.7 | | 34.1 | 27.4 | | | 27.4 | 27.4 |
| Level of Service | | A | | | A | | C | C | | | C | C |
| Approach Delay (s) | | 9.7 | | | 8.7 | | | 33.3 | | | 27.4 | |
| Approach LOS | | A | | | A | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 10.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 72.6 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 96.4% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 analysis supports yellow change in the range of 3 and 6 seconds

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Future Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.990 | | | 0.998 | | | 0.862 | | | | 0.850 |
| Flt Protected | | 0.996 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3490 | 0 | 0 | 3532 | 0 | 1770 | 1606 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.546 | | | 0.950 | | 0.747 | | | | 0.715 | |
| Satd. Flow (perm) | 0 | 1913 | 0 | 0 | 3356 | 0 | 1391 | 1606 | 0 | 0 | 1332 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 17 | | | 4 | | | 60 | | | | 75 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1217 | 92 | 5 | 1766 | 27 | 120 | 5 | 60 | 16 | 0 | 103 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1418 | 0 | 0 | 1798 | 0 | 120 | 65 | 0 | 0 | 16 | 103 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 4 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 40.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 48.5 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 58.5 | 58.5 | | 58.5 | 58.5 | | 21.0 | 21.0 | | 21.0 | 21.0 | 21.0 |
| Total Split (%) | 73.6% | 73.6% | | 73.6% | 73.6% | | 26.4% | 26.4% | | 26.4% | 26.4% | 26.4% |
| Maximum Green (s) | 50.0 | 50.0 | | 50.0 | 50.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | 16.0 |
| Yellow Time (s) | 6.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 54.9 | | | 54.9 | | 12.3 | 12.3 | | | 12.3 | 12.3 |
| Actuated g/C Ratio | | 0.72 | | | 0.72 | | 0.16 | 0.16 | | | 0.16 | 0.16 |
| v/c Ratio | | 1.02 | | | 0.74 | | 0.53 | 0.21 | | | 0.07 | 0.32 |
| Control Delay | | 46.7 | | | 11.6 | | 38.3 | 10.8 | | | 27.2 | 13.8 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 46.7 | | | 11.6 | | 38.3 | 10.8 | | | 27.2 | 13.8 |
| LOS | | D | | | B | | D | B | | | C | B |
| Approach Delay | | 46.7 | | | 11.6 | | | 28.6 | | | 15.6 | |
| Approach LOS | | D | | | B | | | C | | | B | |
| Queue Length 50th (ft) | | ~406 | | | 271 | | 52 | 2 | | | 7 | 11 |
| Queue Length 95th (ft) | | #583 | | | 446 | | 103 | 33 | | | 22 | 51 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1389 | | | 2430 | | 293 | 386 | | | 281 | 393 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 1.02 | | | 0.74 | | 0.41 | 0.17 | | | 0.06 | 0.26 |

Intersection Summary

Area Type: Other

Cycle Length: 79.5

Actuated Cycle Length: 75.8

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.02

Intersection Signal Delay: 26.7 Intersection LOS: C

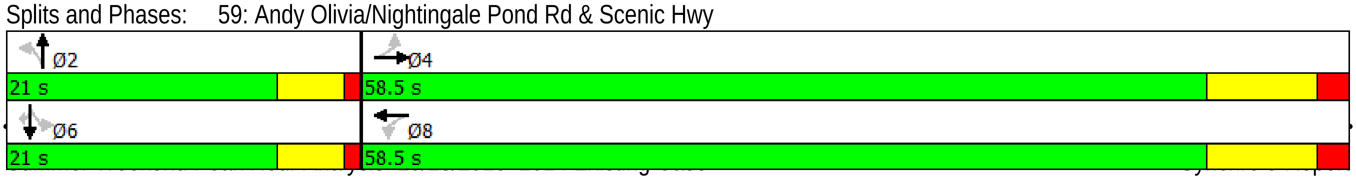
Intersection Capacity Utilization 113.5% ICU Level of Service H

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Future Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 0.99 | | | 1.00 | | 1.00 | 0.86 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3491 | | | 3531 | | 1770 | 1605 | | | 1770 | 1583 |
| Flt Permitted | | 0.55 | | | 0.95 | | 0.75 | 1.00 | | | 0.71 | 1.00 |
| Satd. Flow (perm) | | 1915 | | | 3355 | | 1392 | 1605 | | | 1331 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1217 | 92 | 5 | 1766 | 27 | 120 | 5 | 60 | 16 | 0 | 103 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 52 | 0 | 0 | 0 | 65 |
| Lane Group Flow (vph) | 0 | 1413 | 0 | 0 | 1797 | 0 | 120 | 13 | 0 | 0 | 16 | 38 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 53.1 | | | 53.1 | | 10.2 | 10.2 | | | 10.2 | 10.2 |
| Effective Green, g (s) | | 53.1 | | | 53.1 | | 10.2 | 10.2 | | | 10.2 | 10.2 |
| Actuated g/C Ratio | | 0.69 | | | 0.69 | | 0.13 | 0.13 | | | 0.13 | 0.13 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1324 | | | 2319 | | 184 | 213 | | | 176 | 210 |
| v/s Ratio Prot | | | | | | | | 0.01 | | | | |
| v/s Ratio Perm | | c0.74 | | | 0.54 | | c0.09 | | | | 0.01 | 0.02 |
| v/c Ratio | | 1.07 | | | 0.77 | | 0.65 | 0.06 | | | 0.09 | 0.18 |
| Uniform Delay, d1 | | 11.8 | | | 7.9 | | 31.6 | 29.1 | | | 29.2 | 29.6 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 44.8 | | | 1.7 | | 8.0 | 0.1 | | | 0.2 | 0.4 |
| Delay (s) | | 56.6 | | | 9.6 | | 39.6 | 29.2 | | | 29.5 | 30.0 |
| Level of Service | | E | | | A | | D | C | | | C | C |
| Approach Delay (s) | | 56.6 | | | 9.6 | | | 36.0 | | | 29.9 | |
| Approach LOS | | E | | | A | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 30.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 1.00 | | |
| Actuated Cycle Length (s) | 76.8 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 113.5% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 analysis supports yellow change in the range of 3 and 6 seconds

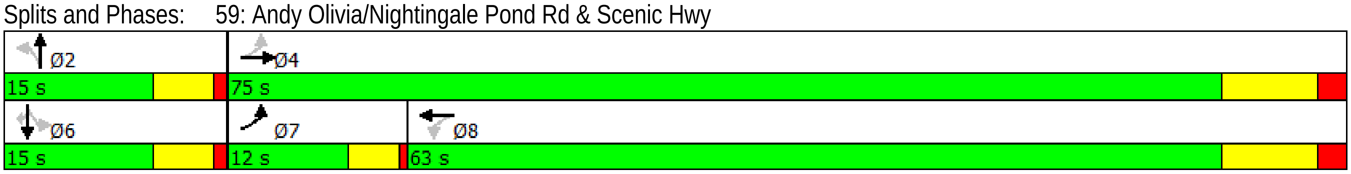
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Future Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.990 | | | 0.998 | | | 0.862 | | | | 0.850 |
| Flt Protected | | 0.996 | | | | | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 0 | 3490 | 0 | 0 | 3532 | 0 | 1770 | 1606 | 0 | 0 | 1770 | 1583 |
| Flt Permitted | | 0.550 | | | 0.950 | | 0.747 | | | | 0.715 | |
| Satd. Flow (perm) | 0 | 1927 | 0 | 0 | 3356 | 0 | 1391 | 1606 | 0 | 0 | 1332 | 1583 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 22 | | | 3 | | | 60 | | | | 115 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 386 | | | 584 | | | 567 | | | 306 | |
| Travel Time (s) | | 8.8 | | | 13.3 | | | 12.9 | | | 7.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1217 | 92 | 5 | 1766 | 27 | 120 | 5 | 60 | 16 | 0 | 103 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 1418 | 0 | 0 | 1798 | 0 | 120 | 65 | 0 | 0 | 16 | 103 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Detector Phase | 7 | 4 | | 8 | 8 | | 2 | 2 | | 6 | 6 | 6 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 4.0 | 40.0 | | 40.0 | 40.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 8.0 | 48.5 | | 48.5 | 48.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (s) | 12.0 | 75.0 | | 63.0 | 63.0 | | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 |
| Total Split (%) | 13.3% | 83.3% | | 70.0% | 70.0% | | 16.7% | 16.7% | | 16.7% | 16.7% | 16.7% |
| Maximum Green (s) | 8.0 | 66.5 | | 54.5 | 54.5 | | 10.0 | 10.0 | | 10.0 | 10.0 | 10.0 |
| Yellow Time (s) | 3.5 | 6.5 | | 6.5 | 6.5 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 0.5 | 2.0 | | 2.0 | 2.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lead/Lag | Lead | | | Lag | Lag | | | | | | | |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | Min | | Min | Min | | None | None | | None | None | None |
| Act Effct Green (s) | | 66.9 | | | 66.9 | | 10.0 | 10.0 | | | 10.0 | 10.0 |
| Actuated g/C Ratio | | 0.74 | | | 0.74 | | 0.11 | 0.11 | | | 0.11 | 0.11 |
| v/c Ratio | | 0.99 | | | 0.72 | | 0.78 | 0.28 | | | 0.11 | 0.37 |
| Control Delay | | 34.8 | | | 8.7 | | 73.2 | 15.2 | | | 38.0 | 10.4 |
| Queue Delay | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 34.8 | | | 8.7 | | 73.2 | 15.2 | | | 38.0 | 10.4 |
| LOS | | C | | | A | | E | B | | | D | B |
| Approach Delay | | 34.8 | | | 8.7 | | | 52.8 | | | 14.1 | |
| Approach LOS | | C | | | A | | | D | | | B | |
| Queue Length 50th (ft) | | 337 | | | 247 | | 68 | 3 | | | 8 | 0 |
| Queue Length 95th (ft) | | #576 | | | 322 | | #160 | 40 | | | 28 | 39 |
| Internal Link Dist (ft) | | 306 | | | 504 | | | 487 | | | 226 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 1431 | | | 2484 | | 153 | 230 | | | 147 | 277 |
| Starvation Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | | 0.99 | | | 0.72 | | 0.78 | 0.28 | | | 0.11 | 0.37 |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90.4
Natural Cycle: 100
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.99
Intersection Signal Delay: 21.7 Intersection LOS: C
Intersection Capacity Utilization 113.5% ICU Level of Service H
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 59: Andy Olivia/Nightingale Pond Rd & Scenic Hwy



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Future Volume (vph) | 100 | 1120 | 85 | 5 | 1625 | 25 | 110 | 5 | 55 | 15 | 0 | 95 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Lane Util. Factor | | 0.95 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Frt | | 0.99 | | | 1.00 | | 1.00 | 0.86 | | | 1.00 | 0.85 |
| Flt Protected | | 1.00 | | | 1.00 | | 0.95 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | | 3491 | | | 3531 | | 1770 | 1605 | | | 1770 | 1583 |
| Flt Permitted | | 0.55 | | | 0.95 | | 0.75 | 1.00 | | | 0.71 | 1.00 |
| Satd. Flow (perm) | | 1926 | | | 3356 | | 1392 | 1605 | | | 1331 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 109 | 1217 | 92 | 5 | 1766 | 27 | 120 | 5 | 60 | 16 | 0 | 103 |
| RTOR Reduction (vph) | 0 | 6 | 0 | 0 | 1 | 0 | 0 | 53 | 0 | 0 | 0 | 92 |
| Lane Group Flow (vph) | 0 | 1412 | 0 | 0 | 1797 | 0 | 120 | 12 | 0 | 0 | 16 | 11 |
| Turn Type | pm+pt | NA | | Perm | NA | | Perm | NA | | Perm | NA | Perm |
| Protected Phases | 7 | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | | 66.9 | | | 66.9 | | 10.0 | 10.0 | | | 10.0 | 10.0 |
| Effective Green, g (s) | | 66.9 | | | 66.9 | | 10.0 | 10.0 | | | 10.0 | 10.0 |
| Actuated g/C Ratio | | 0.74 | | | 0.74 | | 0.11 | 0.11 | | | 0.11 | 0.11 |
| Clearance Time (s) | | 8.5 | | | 8.5 | | 5.0 | 5.0 | | | 5.0 | 5.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 1425 | | | 2483 | | 153 | 177 | | | 147 | 175 |
| v/s Ratio Prot | | | | | | | | 0.01 | | | | |
| v/s Ratio Perm | | c0.73 | | | 0.54 | | c0.09 | | | | 0.01 | 0.01 |
| v/c Ratio | | 0.99 | | | 0.72 | | 0.78 | 0.07 | | | 0.11 | 0.07 |
| Uniform Delay, d1 | | 11.5 | | | 6.6 | | 39.1 | 36.0 | | | 36.2 | 36.0 |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | | 21.6 | | | 1.1 | | 22.6 | 0.2 | | | 0.3 | 0.2 |
| Delay (s) | | 33.1 | | | 7.6 | | 61.8 | 36.2 | | | 36.5 | 36.2 |
| Level of Service | | C | | | A | | E | D | | | D | D |
| Approach Delay (s) | | 33.1 | | | 7.6 | | | 52.8 | | | 36.2 | |
| Approach LOS | | C | | | A | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.2 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 1.02 | | |
| Actuated Cycle Length (s) | 90.4 | Sum of lost time (s) | 17.5 |
| Intersection Capacity Utilization | 113.5% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

# Mid-Term Improvements

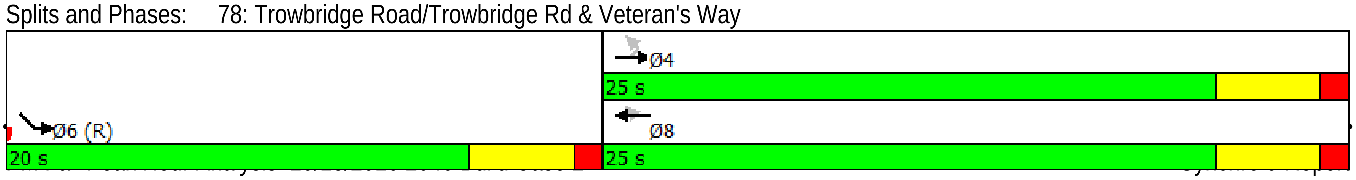
| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 505 | 250 | 20 | 160 | 90 |
| Future Volume (vph) | 15 | 505 | 250 | 20 | 160 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.946 | |
| Flt Protected | | 0.999 | | | 0.969 | |
| Satd. Flow (prot) | 0 | 1808 | 1810 | 1538 | 3218 | 0 |
| Flt Permitted | | 0.989 | | | 0.969 | |
| Satd. Flow (perm) | 0 | 1790 | 1810 | 1538 | 3218 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 22 | 98 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 549 | 272 | 22 | 174 | 98 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 565 | 272 | 22 | 272 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 25.0 | 25.0 | 25.0 | 25.0 | 20.0 | |
| Total Split (%) | 55.6% | 55.6% | 55.6% | 55.6% | 44.4% | |
| Maximum Green (s) | 20.5 | 20.5 | 20.5 | 20.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 19.4 | 19.4 | 19.4 | 16.6 | |
| Actuated g/C Ratio | | 0.43 | 0.43 | 0.43 | 0.37 | |
| v/c Ratio | | 0.73 | 0.35 | 0.03 | 0.22 | |
| Control Delay | | 16.1 | 8.8 | 2.6 | 8.3 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 16.1 | 8.8 | 2.6 | 8.3 | |
| LOS | | B | A | A | A | |
| Approach Delay | | 16.1 | 8.4 | | 8.3 | |
| Approach LOS | | B | A | | A | |
| Queue Length 50th (ft) | | 110 | 43 | 0 | 14 | |
| Queue Length 95th (ft) | | 143 | 58 | 6 | 42 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 867 | 876 | 756 | 1341 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.65 | 0.31 | 0.03 | 0.20 | |

## Intersection Summary

Area Type: Other
Cycle Length: 45
Actuated Cycle Length: 45
Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green
Natural Cycle: 45
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 12.2 Intersection LOS: B
Intersection Capacity Utilization 53.6% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 505 | 250 | 20 | 160 | 90 |
| Future Volume (vph) | 15 | 505 | 250 | 20 | 160 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.95 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Satd. Flow (prot) | | 1807 | 1810 | 1538 | 3218 | |
| Flt Permitted | | 0.99 | 1.00 | 1.00 | 0.97 | |
| Satd. Flow (perm) | | 1789 | 1810 | 1538 | 3218 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 549 | 272 | 22 | 174 | 98 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 13 | 62 | 0 |
| Lane Group Flow (vph) | 0 | 565 | 272 | 9 | 210 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 19.4 | 19.4 | 19.4 | 16.6 | |
| Effective Green, g (s) | | 19.4 | 19.4 | 19.4 | 16.6 | |
| Actuated g/C Ratio | | 0.43 | 0.43 | 0.43 | 0.37 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 771 | 780 | 663 | 1187 | |
| v/s Ratio Prot | | | 0.15 | | c0.07 | |
| v/s Ratio Perm | | c0.32 | | 0.01 | | |
| v/c Ratio | | 0.73 | 0.35 | 0.01 | 0.18 | |
| Uniform Delay, d1 | | 10.6 | 8.6 | 7.3 | 9.6 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 3.6 | 0.3 | 0.0 | 0.3 | |
| Delay (s) | | 14.3 | 8.8 | 7.3 | 9.9 | |
| Level of Service | | B | A | A | A | |
| Approach Delay (s) | | 14.3 | 8.7 | | 9.9 | |
| Approach LOS | | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.8 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 45.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 53.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Future Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.896 | | | | | 0.850 |
| Flt Protected | 0.985 | | | 0.999 | | |
| Satd. Flow (prot) | 3098 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.985 | | | 0.950 | | |
| Satd. Flow (perm) | 3098 | 0 | 0 | 3266 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 353 | | | | | 603 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 158 | 353 | 11 | 984 | 457 | 603 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 511 | 0 | 0 | 995 | 457 | 603 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 35.0 | 27.0 | 27.0 |
| Total Split (%) | 36.4% | | 14.5% | 63.6% | 49.1% | 49.1% |
| Maximum Green (s) | 15.5 | | 4.0 | 30.5 | 22.5 | 22.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.2 | | | 19.2 | 19.2 | 19.2 |
| Actuated g/C Ratio | 0.22 | | | 0.52 | 0.52 | 0.52 |
| v/c Ratio | 0.53 | | | 0.59 | 0.49 | 0.55 |
| Control Delay | 7.1 | | | 7.7 | 7.8 | 2.8 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 7.1 | | | 7.7 | 7.8 | 2.8 |
| LOS | A | | | A | A | A |
| Approach Delay | 7.1 | | | 7.7 | 4.9 | |
| Approach LOS | A | | | A | A | |
| Queue Length 50th (ft) | 12 | | | 55 | 45 | 0 |
| Queue Length 95th (ft) | 52 | | | 126 | 122 | 32 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1577 | | | 2749 | 1227 | 1236 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.32 | | | 0.36 | 0.37 | 0.49 |

Intersection Summary

Area Type: Other

Cycle Length: 55

Actuated Cycle Length: 36.9

Natural Cycle: 55

Control Type: Actuated-Uncoordinated

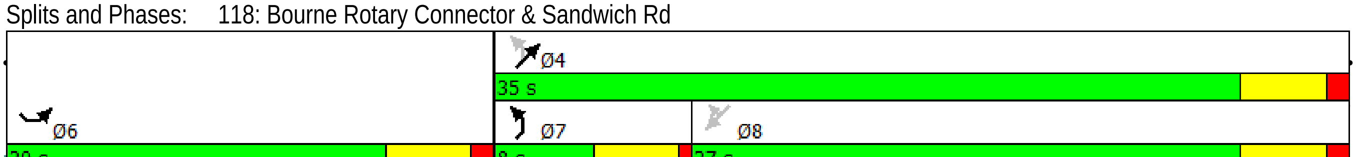
Maximum v/c Ratio: 0.59

Intersection Signal Delay: 6.5 Intersection LOS: A

Intersection Capacity Utilization 67.2% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Future Volume (vph) | 145 | 325 | 10 | 905 | 420 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.90 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.98 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3099 | | | 3436 | 1810 | 1538 |
| Flt Permitted | 0.98 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3099 | | | 3265 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 158 | 353 | 11 | 984 | 457 | 603 |
| RTOR Reduction (vph) | 273 | 0 | 0 | 0 | 0 | 286 |
| Lane Group Flow (vph) | 238 | 0 | 0 | 995 | 457 | 317 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.2 | | | 19.1 | 19.1 | 19.1 |
| Effective Green, g (s) | 8.2 | | | 19.1 | 19.1 | 19.1 |
| Actuated g/C Ratio | 0.23 | | | 0.53 | 0.53 | 0.53 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 700 | | | 1717 | 952 | 809 |
| v/s Ratio Prot | c0.08 | | | | | |
| v/s Ratio Perm | | | | c0.30 | 0.25 | 0.21 |
| v/c Ratio | 0.34 | | | 0.58 | 0.48 | 0.39 |
| Uniform Delay, d1 | 11.8 | | | 5.9 | 5.5 | 5.1 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | | | 0.5 | 0.4 | 0.3 |
| Delay (s) | 12.1 | | | 6.3 | 5.8 | 5.4 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 12.1 | | | 6.3 | 5.6 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.2 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 36.3 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 67.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

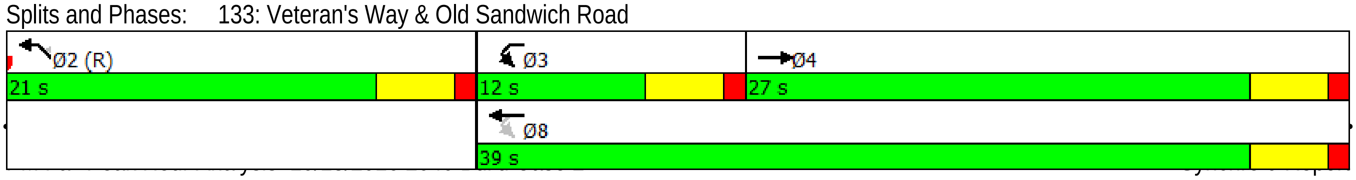
| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 455 | 65 | 185 | 380 | 20 | 15 |
| Future Volume (vph) | 455 | 65 | 185 | 380 | 20 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.983 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1779 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.188 | | 0.950 | |
| Satd. Flow (perm) | 1779 | 0 | 340 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 14 | | | | | 16 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 495 | 71 | 201 | 413 | 22 | 16 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 566 | 0 | 201 | 413 | 22 | 16 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 27.0 | | 12.0 | 39.0 | 21.0 | 21.0 |
| Total Split (%) | 45.0% | | 20.0% | 65.0% | 35.0% | 35.0% |
| Maximum Green (s) | 22.5 | | 7.5 | 34.5 | 16.5 | 16.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 23.9 | | 36.7 | 36.7 | 14.3 | 14.3 |
| Actuated g/C Ratio | 0.40 | | 0.61 | 0.61 | 0.24 | 0.24 |
| v/c Ratio | 0.79 | | 0.50 | 0.37 | 0.05 | 0.04 |
| Control Delay | 23.9 | | 8.9 | 6.2 | 21.8 | 12.3 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 23.9 | | 8.9 | 6.2 | 21.8 | 12.3 |
| LOS | C | | A | A | C | B |
| Approach Delay | 23.9 | | | 7.1 | 17.8 | |
| Approach LOS | C | | | A | B | |
| Queue Length 50th (ft) | 164 | | 26 | 61 | 6 | 0 |
| Queue Length 95th (ft) | 245 | | 33 | 68 | 25 | 15 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 748 | | 403 | 1143 | 507 | 465 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.76 | | 0.50 | 0.36 | 0.04 | 0.03 |

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 60
Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green
Natural Cycle: 60
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 15.2 Intersection LOS: B
Intersection Capacity Utilization 53.6% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 133: Veteran's Way & Old Sandwich Road



| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 455 | 65 | 185 | 380 | 20 | 15 |
| Future Volume (vph) | 455 | 65 | 185 | 380 | 20 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.98 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1779 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.19 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1779 | | 341 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 495 | 71 | 201 | 413 | 22 | 16 |
| RTOR Reduction (vph) | 8 | 0 | 0 | 0 | 0 | 12 |
| Lane Group Flow (vph) | 558 | 0 | 201 | 413 | 22 | 4 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 23.9 | | 36.7 | 36.7 | 14.3 | 14.3 |
| Effective Green, g (s) | 23.9 | | 36.7 | 36.7 | 14.3 | 14.3 |
| Actuated g/C Ratio | 0.40 | | 0.61 | 0.61 | 0.24 | 0.24 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 708 | | 399 | 1107 | 409 | 366 |
| v/s Ratio Prot | c0.31 | | c0.07 | 0.23 | c0.01 | |
| v/s Ratio Perm | | | 0.24 | | | 0.00 |
| v/c Ratio | 0.79 | | 0.50 | 0.37 | 0.05 | 0.01 |
| Uniform Delay, d1 | 15.8 | | 8.2 | 5.9 | 17.6 | 17.4 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 5.8 | | 1.0 | 0.2 | 0.3 | 0.1 |
| Delay (s) | 21.6 | | 9.2 | 6.1 | 17.9 | 17.5 |
| Level of Service | C | | A | A | B | B |
| Approach Delay (s) | 21.6 | | | 7.1 | 17.7 | |
| Approach LOS | C | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.2 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 60.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 53.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 455 | 65 | 185 | 380 | 20 | 15 |
| Future Volume (veh/h) | 455 | 65 | 185 | 380 | 20 | 15 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 495 | 71 | 201 | 413 | 22 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 555 | 80 | 342 | 968 | 543 | 484 |
| Arrive On Green | 0.36 | 0.36 | 0.10 | 0.54 | 0.31 | 0.00 |
| Sat Flow, veh/h | 1548 | 222 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 566 | 201 | 413 | 22 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1770 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 18.1 | 4.0 | 8.2 | 0.5 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 18.1 | 4.0 | 8.2 | 0.5 | 0.0 |
| Prop In Lane | | 0.13 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 635 | 342 | 968 | 543 | 484 |
| V/C Ratio(X) | 0.00 | 0.89 | 0.59 | 0.43 | 0.04 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 664 | 382 | 1040 | 543 | 484 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 0.81 | 0.81 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 18.1 | 12.9 | 8.4 | 14.3 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 13.9 | 1.6 | 0.2 | 0.1 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 11.3 | 2.0 | 4.1 | 0.3 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 32.1 | 14.5 | 8.6 | 14.4 | 0.0 |
| LnGrp LOS | | C | B | A | B | |
| Approach Vol, veh/h | 566 | | | 614 | 22 | |
| Approach Delay, s/veh | 32.1 | | | 10.6 | 14.4 | |
| Approach LOS | C | | | B | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 23.4 | 10.6 | 26.0 | | | | 36.6 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 16.5 | 7.5 | 22.5 | | | | 34.5 |
| Max Q Clear Time (g_c+I1), s | | 2.5 | 6.0 | 20.1 | | | | 10.2 |
| Green Ext Time (p_c), s | | 0.0 | 0.1 | 1.4 | | | | 7.1 |

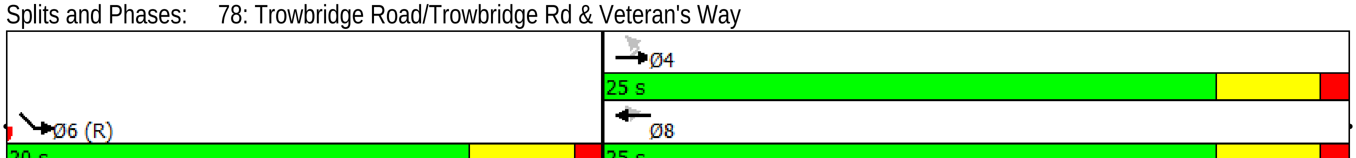
| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 20.8 |
| HCM 2010 LOS | | | C |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 510 | 255 | 20 | 160 | 90 |
| Future Volume (vph) | 15 | 510 | 255 | 20 | 160 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.946 | |
| Flt Protected | | 0.999 | | | 0.969 | |
| Satd. Flow (prot) | 0 | 1808 | 1810 | 1538 | 3218 | 0 |
| Flt Permitted | | 0.989 | | | 0.969 | |
| Satd. Flow (perm) | 0 | 1790 | 1810 | 1538 | 3218 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 22 | 98 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 554 | 277 | 22 | 174 | 98 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 570 | 277 | 22 | 272 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 25.0 | 25.0 | 25.0 | 25.0 | 20.0 | |
| Total Split (%) | 55.6% | 55.6% | 55.6% | 55.6% | 44.4% | |
| Maximum Green (s) | 20.5 | 20.5 | 20.5 | 20.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 19.5 | 19.5 | 19.5 | 16.5 | |
| Actuated g/C Ratio | | 0.43 | 0.43 | 0.43 | 0.37 | |
| v/c Ratio | | 0.74 | 0.35 | 0.03 | 0.22 | |
| Control Delay | | 16.2 | 8.8 | 2.6 | 8.4 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 16.2 | 8.8 | 2.6 | 8.4 | |
| LOS | | B | A | A | A | |
| Approach Delay | | 16.2 | 8.4 | | 8.4 | |
| Approach LOS | | B | A | | A | |
| Queue Length 50th (ft) | | 111 | 43 | 0 | 14 | |
| Queue Length 95th (ft) | | 144 | 59 | 6 | 42 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 868 | 877 | 757 | 1336 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.66 | 0.32 | 0.03 | 0.20 | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 45 | |
| Actuated Cycle Length: 45 | |
| Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green | |
| Natural Cycle: 45 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.74 | |
| Intersection Signal Delay: 12.3 | Intersection LOS: B |
| Intersection Capacity Utilization 53.8% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 510 | 255 | 20 | 160 | 90 |
| Future Volume (vph) | 15 | 510 | 255 | 20 | 160 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.95 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Satd. Flow (prot) | | 1807 | 1810 | 1538 | 3218 | |
| Flt Permitted | | 0.99 | 1.00 | 1.00 | 0.97 | |
| Satd. Flow (perm) | | 1789 | 1810 | 1538 | 3218 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 554 | 277 | 22 | 174 | 98 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 12 | 62 | 0 |
| Lane Group Flow (vph) | 0 | 570 | 277 | 10 | 210 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 19.5 | 19.5 | 19.5 | 16.5 | |
| Effective Green, g (s) | | 19.5 | 19.5 | 19.5 | 16.5 | |
| Actuated g/C Ratio | | 0.43 | 0.43 | 0.43 | 0.37 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 775 | 784 | 666 | 1179 | |
| v/s Ratio Prot | | | 0.15 | | c0.07 | |
| v/s Ratio Perm | | c0.32 | | 0.01 | | |
| v/c Ratio | | 0.74 | 0.35 | 0.01 | 0.18 | |
| Uniform Delay, d1 | | 10.6 | 8.5 | 7.3 | 9.7 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 3.6 | 0.3 | 0.0 | 0.3 | |
| Delay (s) | | 14.3 | 8.8 | 7.3 | 10.0 | |
| Level of Service | | B | A | A | A | |
| Approach Delay (s) | | 14.3 | 8.7 | | 10.0 | |
| Approach LOS | | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.8 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 45.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 53.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

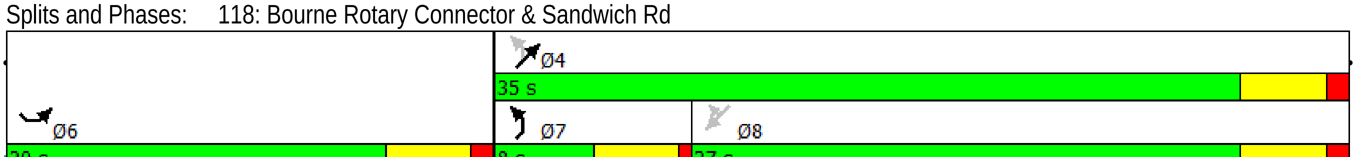
HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 170 | 325 | 10 | 950 | 385 | 560 |
| Future Volume (vph) | 170 | 325 | 10 | 950 | 385 | 560 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.902 | | | | | 0.850 |
| Flt Protected | 0.983 | | | 0.999 | | |
| Satd. Flow (prot) | 3113 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.983 | | | 0.950 | | |
| Satd. Flow (perm) | 3113 | 0 | 0 | 3266 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 353 | | | | | 609 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 185 | 353 | 11 | 1033 | 418 | 609 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 538 | 0 | 0 | 1044 | 418 | 609 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 35.0 | 27.0 | 27.0 |
| Total Split (%) | 36.4% | | 14.5% | 63.6% | 49.1% | 49.1% |
| Maximum Green (s) | 15.5 | | 4.0 | 30.5 | 22.5 | 22.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.6 | | | 20.4 | 20.4 | 20.4 |
| Actuated g/C Ratio | 0.22 | | | 0.53 | 0.53 | 0.53 |
| v/c Ratio | 0.56 | | | 0.60 | 0.44 | 0.55 |
| Control Delay | 7.8 | | | 8.0 | 7.3 | 2.8 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 7.8 | | | 8.0 | 7.3 | 2.8 |
| LOS | A | | | A | A | A |
| Approach Delay | 7.8 | | | 8.0 | 4.6 | |
| Approach LOS | A | | | A | A | |
| Queue Length 50th (ft) | 15 | | | 61 | 41 | 0 |
| Queue Length 95th (ft) | 57 | | | 141 | 114 | 34 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1529 | | | 2646 | 1192 | 1221 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.35 | | | 0.39 | 0.35 | 0.50 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 55 | |
| Actuated Cycle Length: 38.5 | |
| Natural Cycle: 55 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.60 | |
| Intersection Signal Delay: 6.7 | Intersection LOS: A |
| Intersection Capacity Utilization 68.7% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 170 | 325 | 10 | 950 | 385 | 560 |
| Future Volume (vph) | 170 | 325 | 10 | 950 | 385 | 560 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.90 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.98 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3111 | | | 3436 | 1810 | 1538 |
| Flt Permitted | 0.98 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3111 | | | 3268 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 185 | 353 | 11 | 1033 | 418 | 609 |
| RTOR Reduction (vph) | 273 | 0 | 0 | 0 | 0 | 282 |
| Lane Group Flow (vph) | 265 | 0 | 0 | 1044 | 418 | 327 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.6 | | | 20.4 | 20.4 | 20.4 |
| Effective Green, g (s) | 8.6 | | | 20.4 | 20.4 | 20.4 |
| Actuated g/C Ratio | 0.23 | | | 0.54 | 0.54 | 0.54 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 704 | | | 1754 | 971 | 825 |
| v/s Ratio Prot | c0.09 | | | | | |
| v/s Ratio Perm | | | | c0.32 | 0.23 | 0.21 |
| v/c Ratio | 0.38 | | | 0.60 | 0.43 | 0.40 |
| Uniform Delay, d1 | 12.4 | | | 6.0 | 5.3 | 5.2 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | | | 0.5 | 0.3 | 0.3 |
| Delay (s) | 12.8 | | | 6.5 | 5.6 | 5.5 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 12.8 | | | 6.5 | 5.5 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.4 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 38.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 68.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 475 | 65 | 185 | 385 | 20 | 20 |
| Future Volume (vph) | 475 | 65 | 185 | 385 | 20 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.984 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1781 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.179 | | 0.950 | |
| Satd. Flow (perm) | 1781 | 0 | 324 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 14 | | | | | 22 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 71 | 201 | 418 | 22 | 22 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 587 | 0 | 201 | 418 | 22 | 22 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

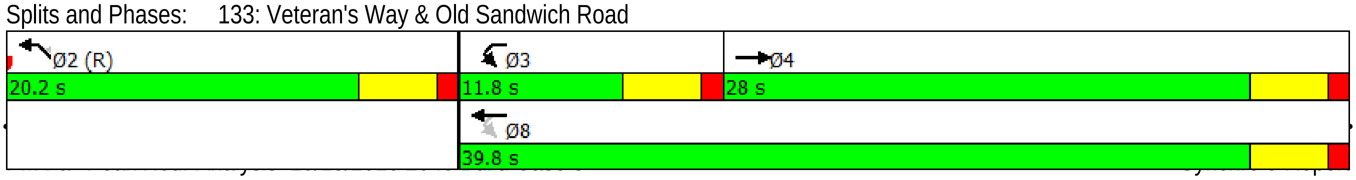
## Lanes, Volumes, Timings
## 133: Veteran's Way & Old Sandwich Road

02/16/2018

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 28.0 | | 11.8 | 39.8 | 20.2 | 20.2 |
| Total Split (%) | 46.7% | | 19.7% | 66.3% | 33.7% | 33.7% |
| Maximum Green (s) | 23.5 | | 7.3 | 35.3 | 15.7 | 15.7 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 24.3 | | 37.2 | 37.2 | 13.8 | 13.8 |
| Actuated g/C Ratio | 0.40 | | 0.62 | 0.62 | 0.23 | 0.23 |
| v/c Ratio | 0.80 | | 0.51 | 0.37 | 0.06 | 0.06 |
| Control Delay | 24.2 | | 9.2 | 6.0 | 22.1 | 11.4 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 24.2 | | 9.2 | 6.0 | 22.1 | 11.4 |
| LOS | C | | A | A | C | B |
| Approach Delay | 24.2 | | | 7.1 | 16.8 | |
| Approach LOS | C | | | A | B | |
| Queue Length 50th (ft) | 170 | | 25 | 61 | 6 | 0 |
| Queue Length 95th (ft) | 260 | | 38 | 69 | 25 | 17 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 769 | | 397 | 1161 | 487 | 451 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.76 | | 0.51 | 0.36 | 0.05 | 0.05 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 60 | |
| Actuated Cycle Length: 60 | |
| Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green | |
| Natural Cycle: 60 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.80 | |
| Intersection Signal Delay: 15.5 | Intersection LOS: B |
| Intersection Capacity Utilization 54.6% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 133: Veteran's Way & Old Sandwich Road



| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 475 | 65 | 185 | 385 | 20 | 20 |
| Future Volume (vph) | 475 | 65 | 185 | 385 | 20 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.98 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1780 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.18 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1780 | | 324 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 71 | 201 | 418 | 22 | 22 |
| RTOR Reduction (vph) | 8 | 0 | 0 | 0 | 0 | 17 |
| Lane Group Flow (vph) | 579 | 0 | 201 | 418 | 22 | 5 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 24.4 | | 37.2 | 37.2 | 13.8 | 13.8 |
| Effective Green, g (s) | 24.4 | | 37.2 | 37.2 | 13.8 | 13.8 |
| Actuated g/C Ratio | 0.41 | | 0.62 | 0.62 | 0.23 | 0.23 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 723 | | 393 | 1122 | 395 | 353 |
| v/s Ratio Prot | c0.33 | | c0.07 | 0.23 | c0.01 | |
| v/s Ratio Perm | | | 0.25 | | | 0.00 |
| v/c Ratio | 0.80 | | 0.51 | 0.37 | 0.06 | 0.01 |
| Uniform Delay, d1 | 15.7 | | 8.2 | 5.6 | 18.0 | 17.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 6.3 | | 1.1 | 0.2 | 0.3 | 0.1 |
| Delay (s) | 22.0 | | 9.3 | 5.8 | 18.3 | 17.9 |
| Level of Service | C | | A | A | B | B |
| Approach Delay (s) | 22.0 | | | 7.0 | 18.1 | |
| Approach LOS | C | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 60.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 54.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 475 | 65 | 185 | 385 | 20 | 20 |
| Future Volume (veh/h) | 475 | 65 | 185 | 385 | 20 | 20 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 516 | 71 | 201 | 418 | 22 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 580 | 80 | 342 | 991 | 521 | 465 |
| Arrive On Green | 0.37 | 0.37 | 0.10 | 0.55 | 0.30 | 0.00 |
| Sat Flow, veh/h | 1557 | 214 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 587 | 201 | 418 | 22 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1772 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 18.7 | 3.9 | 8.2 | 0.5 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 18.7 | 3.9 | 8.2 | 0.5 | 0.0 |
| Prop In Lane | | 0.12 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 660 | 342 | 991 | 521 | 465 |
| V/C Ratio(X) | 0.00 | 0.89 | 0.59 | 0.42 | 0.04 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 694 | 379 | 1065 | 521 | 465 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 0.81 | 0.81 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 17.7 | 12.8 | 8.0 | 14.8 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 13.2 | 1.6 | 0.2 | 0.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 11.4 | 1.9 | 4.1 | 0.3 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 30.8 | 14.4 | 8.2 | 14.9 | 0.0 |
| LnGrp LOS | | C | B | A | B | |
| Approach Vol, veh/h | 587 | | | 619 | 22 | |
| Approach Delay, s/veh | 30.8 | | | 10.2 | 14.9 | |
| Approach LOS | C | | | B | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 22.7 | 10.5 | 26.8 | | | | 37.3 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 15.7 | 7.3 | 23.5 | | | | 35.3 |
| Max Q Clear Time (g_c+I1), s | | 2.5 | 5.9 | 20.7 | | | | 10.2 |
| Green Ext Time (p_c), s | | 0.0 | 0.1 | 1.7 | | | | 7.4 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 20.2 |
| HCM 2010 LOS | | C |

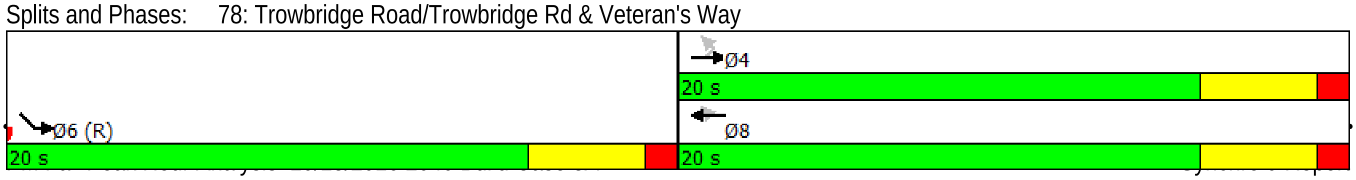
| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 185 | 120 | 20 | 515 | 80 |
| Future Volume (vph) | 15 | 185 | 120 | 20 | 515 | 80 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.980 | |
| Flt Protected | | 0.996 | | | 0.959 | |
| Satd. Flow (prot) | 0 | 1802 | 1810 | 1538 | 3299 | 0 |
| Flt Permitted | | 0.971 | | | 0.959 | |
| Satd. Flow (perm) | 0 | 1757 | 1810 | 1538 | 3299 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 22 | 52 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 201 | 130 | 22 | 560 | 87 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 217 | 130 | 22 | 647 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | |
| Maximum Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 10.1 | 10.1 | 10.1 | 20.9 | |
| Actuated g/C Ratio | | 0.25 | 0.25 | 0.25 | 0.52 | |
| v/c Ratio | | 0.49 | 0.28 | 0.05 | 0.37 | |
| Control Delay | | 15.9 | 12.6 | 5.3 | 6.6 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 15.9 | 12.6 | 5.3 | 6.6 | |
| LOS | | B | B | A | A | |
| Approach Delay | | 15.9 | 11.5 | | 6.6 | |
| Approach LOS | | B | B | | A | |
| Queue Length 50th (ft) | | 41 | 23 | 0 | 34 | |
| Queue Length 95th (ft) | | 73 | 46 | 9 | 73 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 680 | 701 | 609 | 1748 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.32 | 0.19 | 0.04 | 0.37 | |

## Intersection Summary

Area Type: Other
Cycle Length: 40
Actuated Cycle Length: 40
Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green
Natural Cycle: 40
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.49
Intersection Signal Delay: 9.3 Intersection LOS: A
Intersection Capacity Utilization 41.9% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 185 | 120 | 20 | 515 | 80 |
| Future Volume (vph) | 15 | 185 | 120 | 20 | 515 | 80 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (prot) | | 1803 | 1810 | 1538 | 3297 | |
| Flt Permitted | | 0.97 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (perm) | | 1758 | 1810 | 1538 | 3297 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 201 | 130 | 22 | 560 | 87 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 16 | 25 | 0 |
| Lane Group Flow (vph) | 0 | 217 | 130 | 6 | 622 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 10.1 | 10.1 | 10.1 | 20.9 | |
| Effective Green, g (s) | | 10.1 | 10.1 | 10.1 | 20.9 | |
| Actuated g/C Ratio | | 0.25 | 0.25 | 0.25 | 0.52 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 443 | 457 | 388 | 1722 | |
| v/s Ratio Prot | | | 0.07 | | c0.19 | |
| v/s Ratio Perm | | c0.12 | | 0.00 | | |
| v/c Ratio | | 0.49 | 0.28 | 0.01 | 0.36 | |
| Uniform Delay, d1 | | 12.8 | 12.0 | 11.2 | 5.6 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.9 | 0.3 | 0.0 | 0.6 | |
| Delay (s) | | 13.6 | 12.4 | 11.2 | 6.2 | |
| Level of Service | | B | B | B | A | |
| Approach Delay (s) | | 13.6 | 12.2 | | 6.2 | |
| Approach LOS | | B | B | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 8.7 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 41.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 600 | 0 | 960 | 25 | 910 |
| Future Volume (vph) | 195 | 600 | 0 | 960 | 25 | 910 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 0 |
| Storage Lanes | 1 | 0 | 0 | | | 0 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.887 | | | | 0.869 | |
| Flt Protected | 0.988 | | | | | |
| Satd. Flow (prot) | 3076 | 0 | 0 | 3438 | 1572 | 0 |
| Flt Permitted | 0.988 | | | | | |
| Satd. Flow (perm) | 3076 | 0 | 0 | 3438 | 1572 | 0 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 652 | | | | 989 | |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 652 | 0 | 1043 | 27 | 989 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 864 | 0 | 0 | 1043 | 1016 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | |
| Detector Template | Left | | Left | Thru | Thru | |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | | NA | NA | |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | |

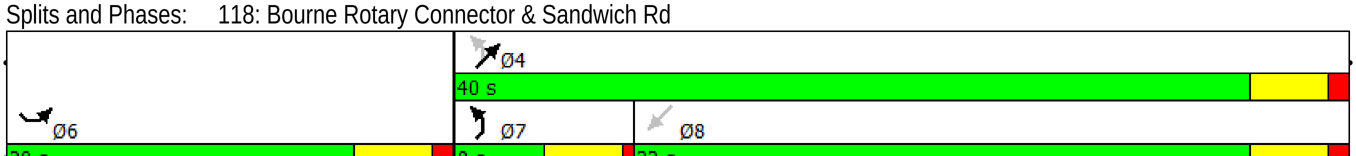
Lanes, Volumes, Timings
118: Bourne Rotary Connector & Sandwich Rd 02/19/2018

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | |
| Total Split (s) | 20.0 | | 8.0 | 40.0 | 32.0 | |
| Total Split (%) | 33.3% | | 13.3% | 66.7% | 53.3% | |
| Maximum Green (s) | 15.5 | | 4.0 | 35.5 | 27.5 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | |
| Lead/Lag | | | Lead | | Lag | |
| Lead-Lag Optimize? | | | Yes | | Yes | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | | None | Min | Min | |
| Walk Time (s) | | | | | 7.0 | |
| Flash Dont Walk (s) | | | | | 11.0 | |
| Pedestrian Calls (#/hr) | | | | | 0 | |
| Act Effct Green (s) | 10.1 | | | 21.0 | 21.0 | |
| Actuated g/C Ratio | 0.25 | | | 0.51 | 0.51 | |
| v/c Ratio | 0.69 | | | 0.59 | 0.79 | |
| Control Delay | 7.4 | | | 8.5 | 6.3 | |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | |
| Total Delay | 7.4 | | | 8.5 | 6.3 | |
| LOS | A | | | A | A | |
| Approach Delay | 7.4 | | | 8.5 | 6.3 | |
| Approach LOS | A | | | A | A | |
| Queue Length 50th (ft) | 19 | | | 69 | 2 | |
| Queue Length 95th (ft) | 71 | | | 144 | 48 | |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | |
| Base Capacity (vph) | 1641 | | | 2934 | 1416 | |
| Starvation Cap Reductn | 0 | | | 0 | 0 | |
| Spillback Cap Reductn | 0 | | | 0 | 0 | |
| Storage Cap Reductn | 0 | | | 0 | 0 | |
| Reduced v/c Ratio | 0.53 | | | 0.36 | 0.72 | |

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 40.8
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 7.4 Intersection LOS: A
Intersection Capacity Utilization 89.7% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 600 | 0 | 960 | 25 | 910 |
| Future Volume (vph) | 195 | 600 | 0 | 960 | 25 | 910 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | |
| Frt | 0.89 | | | 1.00 | 0.87 | |
| Flt Protected | 0.99 | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3075 | | | 3438 | 1572 | |
| Flt Permitted | 0.99 | | | 1.00 | 1.00 | |
| Satd. Flow (perm) | 3075 | | | 3438 | 1572 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 652 | 0 | 1043 | 27 | 989 |
| RTOR Reduction (vph) | 488 | 0 | 0 | 0 | 471 | 0 |
| Lane Group Flow (vph) | 376 | 0 | 0 | 1043 | 545 | 0 |
| Turn Type | Prot | | | NA | NA | |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | |
| Actuated Green, G (s) | 10.1 | | | 21.0 | 21.0 | |
| Effective Green, g (s) | 10.1 | | | 21.0 | 21.0 | |
| Actuated g/C Ratio | 0.25 | | | 0.52 | 0.52 | |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 774 | | | 1800 | 823 | |
| v/s Ratio Prot | c0.12 | | | 0.30 | | |
| v/s Ratio Perm | | | | | c0.35 | |
| v/c Ratio | 0.49 | | | 0.58 | 0.66 | |
| Uniform Delay, d1 | 12.8 | | | 6.5 | 7.0 | |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.5 | | | 0.5 | 2.0 | |
| Delay (s) | 13.3 | | | 7.0 | 9.0 | |
| Level of Service | B | | | A | A | |
| Approach Delay (s) | 13.3 | | | 7.0 | 9.0 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 9.5 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 40.1 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 89.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Research does not support Non-NEMA phasing.

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 780 | 65 | 530 | 380 | 20 | 15 |
| Future Volume (vph) | 780 | 65 | 530 | 380 | 20 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.990 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1791 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.111 | | 0.950 | |
| Satd. Flow (perm) | 1791 | 0 | 201 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 8 | | | | | 16 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 848 | 71 | 576 | 413 | 22 | 16 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 919 | 0 | 576 | 413 | 22 | 16 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 26.0 | | 13.0 | 39.0 | 21.0 | 21.0 |
| Total Split (%) | 43.3% | | 21.7% | 65.0% | 35.0% | 35.0% |
| Maximum Green (s) | 21.5 | | 8.5 | 34.5 | 16.5 | 16.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 31.6 | | 44.6 | 44.6 | 6.4 | 6.4 |
| Actuated g/C Ratio | 0.53 | | 0.74 | 0.74 | 0.11 | 0.11 |
| v/c Ratio | 0.97 | | 1.58 | 0.31 | 0.12 | 0.09 |
| Control Delay | 40.0 | | 296.0 | 3.4 | 25.3 | 13.7 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 40.0 | | 296.0 | 3.4 | 25.3 | 13.7 |
| LOS | D | | F | A | C | B |
| Approach Delay | 40.0 | | | 173.8 | 20.4 | |
| Approach LOS | D | | | F | C | |
| Queue Length 50th (ft) | 289 | | ~261 | 34 | 7 | 0 |
| Queue Length 95th (ft) | #568 | | #442 | 68 | 25 | 15 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 948 | | 364 | 1346 | 472 | 434 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.97 | | 1.58 | 0.31 | 0.05 | 0.04 |

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 60
Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.58
Intersection Signal Delay: 107.6 Intersection LOS: F
Intersection Capacity Utilization 89.8% ICU Level of Service E
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 133: Veteran's Way & Old Sandwich Road

# HCM Signalized Intersection Capacity Analysis
## 133: Veteran's Way & Old Sandwich Road

02/19/2018

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 780 | 65 | 530 | 380 | 20 | 15 |
| Future Volume (vph) | 780 | 65 | 530 | 380 | 20 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1791 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.11 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1791 | | 201 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 848 | 71 | 576 | 413 | 22 | 16 |
| RTOR Reduction (vph) | 4 | 0 | 0 | 0 | 0 | 14 |
| Lane Group Flow (vph) | 915 | 0 | 576 | 413 | 22 | 2 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 31.6 | | 44.6 | 44.6 | 6.4 | 6.4 |
| Effective Green, g (s) | 31.6 | | 44.6 | 44.6 | 6.4 | 6.4 |
| Actuated g/C Ratio | 0.53 | | 0.74 | 0.74 | 0.11 | 0.11 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 943 | | 364 | 1345 | 183 | 164 |
| v/s Ratio Prot | 0.51 | | c0.22 | 0.23 | c0.01 | |
| v/s Ratio Perm | | | c0.95 | | | 0.00 |
| v/c Ratio | 0.97 | | 1.58 | 0.31 | 0.12 | 0.01 |
| Uniform Delay, d1 | 13.7 | | 19.7 | 2.6 | 24.3 | 24.0 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 22.3 | | 274.9 | 0.1 | 1.3 | 0.1 |
| Delay (s) | 36.1 | | 294.6 | 2.7 | 25.6 | 24.1 |
| Level of Service | D | | F | A | C | C |
| Approach Delay (s) | 36.1 | | | 172.7 | 25.0 | |
| Approach LOS | D | | | F | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 105.3 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.46 | | |
| Actuated Cycle Length (s) | 60.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 89.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 780 | 65 | 530 | 380 | 20 | 15 |
| Future Volume (veh/h) | 780 | 65 | 530 | 380 | 20 | 15 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 848 | 71 | 576 | 413 | 22 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 590 | 49 | 364 | 1040 | 474 | 423 |
| Arrive On Green | 0.36 | 0.36 | 0.14 | 0.57 | 0.28 | 0.00 |
| Sat Flow, veh/h | 1647 | 138 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 919 | 576 | 413 | 22 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1785 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 21.5 | 8.5 | 7.5 | 0.6 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 21.5 | 8.5 | 7.5 | 0.6 | 0.0 |
| Prop In Lane | | 0.08 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 640 | 364 | 1040 | 474 | 423 |
| V/C Ratio(X) | 0.00 | 1.44 | 1.58 | 0.40 | 0.05 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 640 | 364 | 1040 | 474 | 423 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 19.3 | 24.3 | 7.0 | 16.0 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 205.3 | 274.6 | 0.2 | 0.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 47.0 | 33.7 | 3.7 | 0.3 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 224.6 | 299.0 | 7.3 | 16.2 | 0.0 |
| LnGrp LOS | | F | F | A | B | |
| Approach Vol, veh/h | 919 | | | 989 | 22 | |
| Approach Delay, s/veh | 224.6 | | | 177.2 | 16.2 | |
| Approach LOS | F | | | F | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 21.0 | 13.0 | 26.0 | | | | 39.0 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 16.5 | 8.5 | 21.5 | | | | 34.5 |
| Max Q Clear Time (g_c+I1), s | | 2.6 | 10.5 | 23.5 | | | | 9.5 |
| Green Ext Time (p_c), s | | 0.0 | 0.0 | 0.0 | | | | 4.9 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 197.9 |
| HCM 2010 LOS | | F |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 5 | 465 | 290 | 25 | 545 | 55 |
| Future Volume (vph) | 5 | 465 | 290 | 25 | 545 | 55 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.986 | |
| Flt Protected | | | | | 0.957 | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 1538 | 3312 | 0 |
| Flt Permitted | | 0.996 | | | 0.957 | |
| Satd. Flow (perm) | 0 | 1802 | 1810 | 1538 | 3312 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 27 | 32 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 505 | 315 | 27 | 592 | 60 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 510 | 315 | 27 | 652 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | |
| Maximum Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 14.8 | 14.8 | 14.8 | 16.2 | |
| Actuated g/C Ratio | | 0.37 | 0.37 | 0.37 | 0.40 | |
| v/c Ratio | | 0.77 | 0.47 | 0.05 | 0.48 | |
| Control Delay | | 20.9 | 11.9 | 4.1 | 10.2 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 20.9 | 11.9 | 4.1 | 10.2 | |
| LOS | | C | B | A | B | |
| Approach Delay | | 20.9 | 11.3 | | 10.2 | |
| Approach LOS | | C | B | | B | |
| Queue Length 50th (ft) | | 85 | 45 | 0 | 54 | |
| Queue Length 95th (ft) | | #214 | 97 | 9 | 84 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 718 | 721 | 629 | 1400 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.71 | 0.44 | 0.04 | 0.47 | |

Intersection Summary

Area Type: Other

Cycle Length: 40

Actuated Cycle Length: 40

Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green

Natural Cycle: 40

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.77

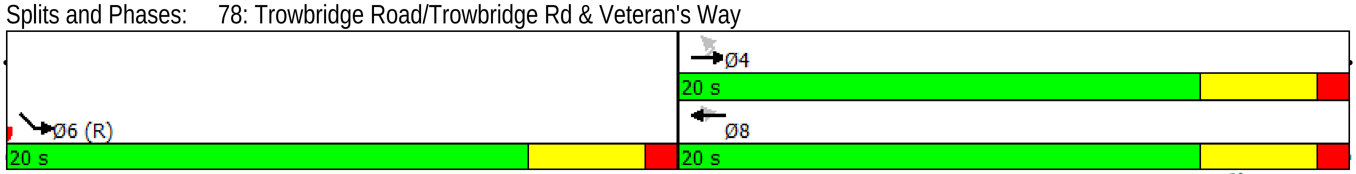
Intersection Signal Delay: 14.1 Intersection LOS: B

Intersection Capacity Utilization 53.2% ICU Level of Service A

Analysis Period (min) 15

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 5 | 465 | 290 | 25 | 545 | 55 |
| Future Volume (vph) | 5 | 465 | 290 | 25 | 545 | 55 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (prot) | | 1809 | 1810 | 1538 | 3312 | |
| Flt Permitted | | 1.00 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (perm) | | 1803 | 1810 | 1538 | 3312 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 505 | 315 | 27 | 592 | 60 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 17 | 19 | 0 |
| Lane Group Flow (vph) | 0 | 510 | 315 | 10 | 633 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 14.8 | 14.8 | 14.8 | 16.2 | |
| Effective Green, g (s) | | 14.8 | 14.8 | 14.8 | 16.2 | |
| Actuated g/C Ratio | | 0.37 | 0.37 | 0.37 | 0.40 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 667 | 669 | 569 | 1341 | |
| v/s Ratio Prot | | | 0.17 | | c0.19 | |
| v/s Ratio Perm | | c0.28 | | 0.01 | | |
| v/c Ratio | | 0.76 | 0.47 | 0.02 | 0.47 | |
| Uniform Delay, d1 | | 11.1 | 9.6 | 8.0 | 8.8 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 5.2 | 0.5 | 0.0 | 1.2 | |
| Delay (s) | | 16.3 | 10.1 | 8.0 | 9.9 | |
| Level of Service | | B | B | A | A | |
| Approach Delay (s) | | 16.3 | 10.0 | | 9.9 | |
| Approach LOS | | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.1 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 53.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Future Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.942 | | | | | 0.850 |
| Flt Protected | 0.970 | | | 0.999 | | |
| Satd. Flow (prot) | 3208 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.970 | | | 0.946 | | |
| Satd. Flow (perm) | 3208 | 0 | 0 | 3252 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 136 | | | | | 837 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 217 | 136 | 27 | 1250 | 293 | 837 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 353 | 0 | 0 | 1277 | 293 | 837 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

Lanes, Volumes, Timings

118: Bourne Rotary Connector & Sandwich Rd 02/16/2018

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 40.0 | 32.0 | 32.0 |
| Total Split (%) | 33.3% | | 13.3% | 66.7% | 53.3% | 53.3% |
| Maximum Green (s) | 15.5 | | 4.0 | 35.5 | 27.5 | 27.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Actuated g/C Ratio | 0.20 | | | 0.59 | 0.59 | 0.59 |
| v/c Ratio | 0.47 | | | 0.67 | 0.27 | 0.67 |
| Control Delay | 13.0 | | | 8.2 | 5.3 | 3.5 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 13.0 | | | 8.2 | 5.3 | 3.5 |
| LOS | B | | | A | A | A |
| Approach Delay | 13.0 | | | 8.2 | 4.0 | |
| Approach LOS | B | | | A | A | |
| Queue Length 50th (ft) | 24 | | | 90 | 29 | 0 |
| Queue Length 95th (ft) | 63 | | | 173 | 68 | 34 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1258 | | | 2629 | 1258 | 1324 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.28 | | | 0.49 | 0.23 | 0.63 |

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 44.5

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

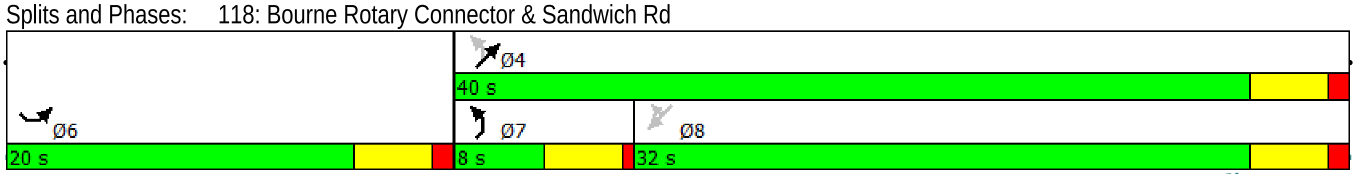
Maximum v/c Ratio: 0.67

Intersection Signal Delay: 7.1 Intersection LOS: A

Intersection Capacity Utilization 87.7% ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Future Volume (vph) | 200 | 125 | 25 | 1150 | 270 | 770 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.94 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.97 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3209 | | | 3434 | 1810 | 1538 |
| Flt Permitted | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3209 | | | 3252 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 217 | 136 | 27 | 1250 | 293 | 837 |
| RTOR Reduction (vph) | 109 | 0 | 0 | 0 | 0 | 339 |
| Lane Group Flow (vph) | 244 | 0 | 0 | 1277 | 293 | 498 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Effective Green, g (s) | 8.8 | | | 26.2 | 26.2 | 26.2 |
| Actuated g/C Ratio | 0.20 | | | 0.60 | 0.60 | 0.60 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 641 | | | 1936 | 1077 | 915 |
| v/s Ratio Prot | c0.08 | | | | | |
| v/s Ratio Perm | | | | c0.39 | 0.16 | 0.32 |
| v/c Ratio | 0.38 | | | 0.66 | 0.27 | 0.54 |
| Uniform Delay, d1 | 15.2 | | | 5.9 | 4.3 | 5.3 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | | | 0.8 | 0.1 | 0.7 |
| Delay (s) | 15.6 | | | 6.8 | 4.4 | 6.0 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 15.6 | | | 6.8 | 5.6 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.4 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.67 | | |
| Actuated Cycle Length (s) | 44.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 87.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

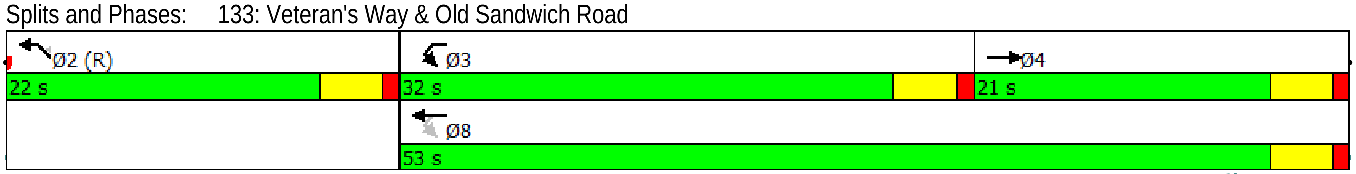
| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 315 | 10 | 590 | 205 | 25 | 10 |
| Future Volume (vph) | 315 | 10 | 590 | 205 | 25 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.996 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1802 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.226 | | 0.950 | |
| Satd. Flow (perm) | 1802 | 0 | 409 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 2 | | | | | 11 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 342 | 11 | 641 | 223 | 27 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 353 | 0 | 641 | 223 | 27 | 11 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 21.0 | | 32.0 | 53.0 | 22.0 | 22.0 |
| Total Split (%) | 28.0% | | 42.7% | 70.7% | 29.3% | 29.3% |
| Maximum Green (s) | 16.5 | | 27.5 | 48.5 | 17.5 | 17.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 18.8 | | 52.6 | 52.6 | 13.4 | 13.4 |
| Actuated g/C Ratio | 0.25 | | 0.70 | 0.70 | 0.18 | 0.18 |
| v/c Ratio | 0.78 | | 0.80 | 0.18 | 0.09 | 0.04 |
| Control Delay | 40.6 | | 18.9 | 3.6 | 30.6 | 17.0 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 40.6 | | 18.9 | 3.6 | 30.6 | 17.0 |
| LOS | D | | B | A | C | B |
| Approach Delay | 40.6 | | | 14.9 | 26.6 | |
| Approach LOS | D | | | B | C | |
| Queue Length 50th (ft) | 145 | | 167 | 25 | 11 | 0 |
| Queue Length 95th (ft) | #309 | | 252 | 35 | 34 | 14 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 460 | | 819 | 1301 | 431 | 394 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.77 | | 0.78 | 0.17 | 0.06 | 0.03 |

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 75
Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green
Natural Cycle: 75
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 22.5 Intersection LOS: C
Intersection Capacity Utilization 65.3% ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 133: Veteran's Way & Old Sandwich Road



| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 315 | 10 | 590 | 205 | 25 | 10 |
| Future Volume (vph) | 315 | 10 | 590 | 205 | 25 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1802 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.23 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1802 | | 409 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 342 | 11 | 641 | 223 | 27 | 11 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 9 |
| Lane Group Flow (vph) | 352 | 0 | 641 | 223 | 27 | 2 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 18.8 | | 52.7 | 52.7 | 13.3 | 13.3 |
| Effective Green, g (s) | 18.8 | | 52.7 | 52.7 | 13.3 | 13.3 |
| Actuated g/C Ratio | 0.25 | | 0.70 | 0.70 | 0.18 | 0.18 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 451 | | 800 | 1271 | 304 | 272 |
| v/s Ratio Prot | 0.20 | | c0.31 | 0.12 | c0.02 | |
| v/s Ratio Perm | | | c0.25 | | | 0.00 |
| v/c Ratio | 0.78 | | 0.80 | 0.18 | 0.09 | 0.01 |
| Uniform Delay, d1 | 26.2 | | 12.2 | 3.8 | 25.8 | 25.4 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 8.3 | | 5.8 | 0.1 | 0.6 | 0.0 |
| Delay (s) | 34.5 | | 18.0 | 3.8 | 26.4 | 25.5 |
| Level of Service | C | | B | A | C | C |
| Approach Delay (s) | 34.5 | | | 14.4 | 26.1 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 20.4 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 65.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 315 | 10 | 590 | 205 | 25 | 10 |
| Future Volume (veh/h) | 315 | 10 | 590 | 205 | 25 | 10 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 342 | 11 | 641 | 223 | 27 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 381 | 12 | 684 | 1093 | 476 | 425 |
| Arrive On Green | 0.22 | 0.22 | 0.33 | 0.60 | 0.28 | 0.00 |
| Sat Flow, veh/h | 1744 | 56 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 353 | 641 | 223 | 27 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1800 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 14.3 | 21.4 | 4.2 | 0.9 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 14.3 | 21.4 | 4.2 | 0.9 | 0.0 |
| Prop In Lane | | 0.03 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 393 | 684 | 1093 | 476 | 425 |
| V/C Ratio(X) | 0.00 | 0.90 | 0.94 | 0.20 | 0.06 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 396 | 755 | 1170 | 476 | 425 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 0.69 | 0.69 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 28.5 | 16.0 | 6.7 | 20.0 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 22.5 | 13.8 | 0.1 | 0.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 9.5 | 15.3 | 2.1 | 0.4 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 51.0 | 29.7 | 6.8 | 20.2 | 0.0 |
| LnGrp LOS | | D | C | A | C | |
| Approach Vol, veh/h | 353 | | | 864 | 27 | |
| Approach Delay, s/veh | 51.0 | | | 23.8 | 20.2 | |
| Approach LOS | D | | | C | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 25.2 | 28.9 | 20.9 | | | | 49.8 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 17.5 | 27.5 | 16.5 | | | | 48.5 |
| Max Q Clear Time (g_c+I1), s | | 2.9 | 23.4 | 16.3 | | | | 6.2 |
| Green Ext Time (p_c), s | | 0.0 | 1.0 | 0.1 | | | | 4.0 |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 31.4 |
| HCM 2010 LOS | | | C |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 25 | 440 | 310 | 30 | 480 | 50 |
| Future Volume (vph) | 25 | 440 | 310 | 30 | 480 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.986 | |
| Flt Protected | | 0.997 | | | 0.957 | |
| Satd. Flow (prot) | 0 | 1804 | 1810 | 1538 | 3312 | 0 |
| Flt Permitted | | 0.970 | | | 0.957 | |
| Satd. Flow (perm) | 0 | 1755 | 1810 | 1538 | 3312 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 33 | 33 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 27 | 478 | 337 | 33 | 522 | 54 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 505 | 337 | 33 | 576 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

## Lanes, Volumes, Timings
## 78: Trowbridge Road/Trowbridge Rd & Veteran's Way

02/16/2018

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | |
| Maximum Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 15.2 | 15.2 | 15.2 | 15.8 | |
| Actuated g/C Ratio | | 0.38 | 0.38 | 0.38 | 0.40 | |
| v/c Ratio | | 0.76 | 0.49 | 0.05 | 0.43 | |
| Control Delay | | 20.4 | 11.9 | 3.8 | 10.1 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 20.4 | 11.9 | 3.8 | 10.1 | |
| LOS | | C | B | A | B | |
| Approach Delay | | 20.4 | 11.2 | | 10.1 | |
| Approach LOS | | C | B | | B | |
| Queue Length 50th (ft) | | 83 | 49 | 0 | 46 | |
| Queue Length 95th (ft) | | #215 | 105 | 11 | 72 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 715 | 737 | 646 | 1395 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.71 | 0.46 | 0.05 | 0.41 | |

**Intersection Summary**

Area Type: Other

Cycle Length: 40

Actuated Cycle Length: 40

Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green

Natural Cycle: 40

Control Type: Actuated-Coordinated

Maximum v/c Ratio: 0.76

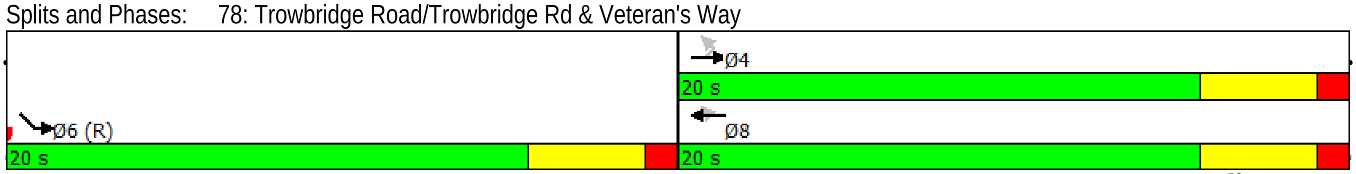
Intersection Signal Delay: 14.0 Intersection LOS: B

Intersection Capacity Utilization 66.3% ICU Level of Service C

Analysis Period (min) 15

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 25 | 440 | 310 | 30 | 480 | 50 |
| Future Volume (vph) | 25 | 440 | 310 | 30 | 480 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (prot) | | 1805 | 1810 | 1538 | 3311 | |
| Flt Permitted | | 0.97 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (perm) | | 1754 | 1810 | 1538 | 3311 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 27 | 478 | 337 | 33 | 522 | 54 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 20 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 505 | 337 | 13 | 556 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 15.2 | 15.2 | 15.2 | 15.8 | |
| Effective Green, g (s) | | 15.2 | 15.2 | 15.2 | 15.8 | |
| Actuated g/C Ratio | | 0.38 | 0.38 | 0.38 | 0.40 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 666 | 687 | 584 | 1307 | |
| v/s Ratio Prot | | | 0.19 | | c0.17 | |
| v/s Ratio Perm | | c0.29 | | 0.01 | | |
| v/c Ratio | | 0.76 | 0.49 | 0.02 | 0.43 | |
| Uniform Delay, d1 | | 10.8 | 9.4 | 7.8 | 8.8 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 4.9 | 0.6 | 0.0 | 1.0 | |
| Delay (s) | | 15.7 | 10.0 | 7.8 | 9.8 | |
| Level of Service | | B | B | A | A | |
| Approach Delay (s) | | 15.7 | 9.8 | | 9.8 | |
| Approach LOS | | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 11.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 66.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

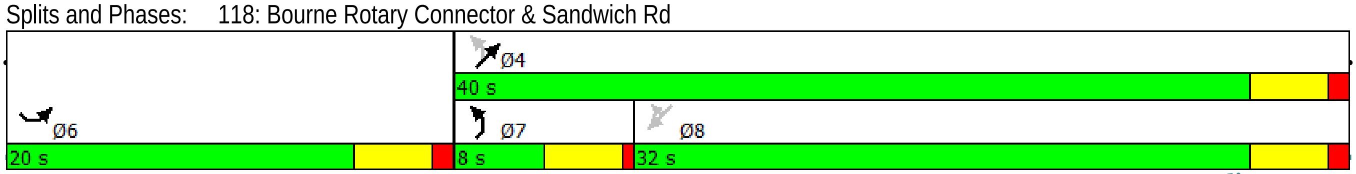
HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 125 | 25 | 1260 | 350 | 695 |
| Future Volume (vph) | 195 | 125 | 25 | 1260 | 350 | 695 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.941 | | | | | 0.850 |
| Flt Protected | 0.970 | | | 0.999 | | |
| Satd. Flow (prot) | 3204 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.970 | | | 0.945 | | |
| Satd. Flow (perm) | 3204 | 0 | 0 | 3249 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 136 | | | | | 755 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 136 | 27 | 1370 | 380 | 755 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 348 | 0 | 0 | 1397 | 380 | 755 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 40.0 | 32.0 | 32.0 |
| Total Split (%) | 33.3% | | 13.3% | 66.7% | 53.3% | 53.3% |
| Maximum Green (s) | 15.5 | | 4.0 | 35.5 | 27.5 | 27.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 8.9 | | | 28.9 | 28.9 | 28.9 |
| Actuated g/C Ratio | 0.19 | | | 0.61 | 0.61 | 0.61 |
| v/c Ratio | 0.49 | | | 0.70 | 0.34 | 0.61 |
| Control Delay | 13.8 | | | 8.6 | 5.5 | 2.9 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 13.8 | | | 8.6 | 5.5 | 2.9 |
| LOS | B | | | A | A | A |
| Approach Delay | 13.8 | | | 8.6 | 3.8 | |
| Approach LOS | B | | | A | A | |
| Queue Length 50th (ft) | 27 | | | 106 | 40 | 0 |
| Queue Length 95th (ft) | 62 | | | 200 | 90 | 32 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1185 | | | 2503 | 1226 | 1285 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.29 | | | 0.56 | 0.31 | 0.59 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 60 | |
| Actuated Cycle Length: 47.1 | |
| Natural Cycle: 60 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.70 | |
| Intersection Signal Delay: 7.3 | Intersection LOS: A |
| Intersection Capacity Utilization 86.1% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 125 | 25 | 1260 | 350 | 695 |
| Future Volume (vph) | 195 | 125 | 25 | 1260 | 350 | 695 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.94 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.97 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3207 | | | 3435 | 1810 | 1538 |
| Flt Permitted | 0.97 | | | 0.94 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3207 | | | 3249 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 136 | 27 | 1370 | 380 | 755 |
| RTOR Reduction (vph) | 110 | 0 | 0 | 0 | 0 | 289 |
| Lane Group Flow (vph) | 238 | 0 | 0 | 1397 | 380 | 466 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 8.9 | | | 28.9 | 28.9 | 28.9 |
| Effective Green, g (s) | 8.9 | | | 28.9 | 28.9 | 28.9 |
| Actuated g/C Ratio | 0.19 | | | 0.62 | 0.62 | 0.62 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 609 | | | 2006 | 1117 | 949 |
| v/s Ratio Prot | c0.07 | | | | | |
| v/s Ratio Perm | | | | c0.43 | 0.21 | 0.30 |
| v/c Ratio | 0.39 | | | 0.70 | 0.34 | 0.49 |
| Uniform Delay, d1 | 16.6 | | | 6.0 | 4.3 | 4.9 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | | | 1.1 | 0.2 | 0.4 |
| Delay (s) | 17.0 | | | 7.1 | 4.5 | 5.3 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 17.0 | | | 7.1 | 5.0 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.5 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 46.8 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 86.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

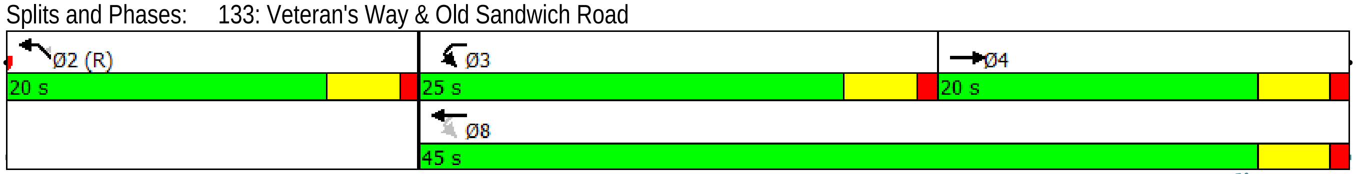
| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 285 | 10 | 520 | 200 | 25 | 35 |
| Future Volume (vph) | 285 | 10 | 520 | 200 | 25 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.995 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1800 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.262 | | 0.950 | |
| Satd. Flow (perm) | 1800 | 0 | 474 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 3 | | | | | 38 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 310 | 11 | 565 | 217 | 27 | 38 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 321 | 0 | 565 | 217 | 27 | 38 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | | 25.0 | 45.0 | 20.0 | 20.0 |
| Total Split (%) | 30.8% | | 38.5% | 69.2% | 30.8% | 30.8% |
| Maximum Green (s) | 15.5 | | 20.5 | 40.5 | 15.5 | 15.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 15.4 | | 41.6 | 41.6 | 14.4 | 14.4 |
| Actuated g/C Ratio | 0.24 | | 0.64 | 0.64 | 0.22 | 0.22 |
| v/c Ratio | 0.75 | | 0.79 | 0.19 | 0.07 | 0.10 |
| Control Delay | 35.2 | | 17.4 | 4.4 | 24.6 | 10.5 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 35.2 | | 17.4 | 4.4 | 24.6 | 10.5 |
| LOS | D | | B | A | C | B |
| Approach Delay | 35.2 | | | 13.8 | 16.4 | |
| Approach LOS | D | | | B | B | |
| Queue Length 50th (ft) | 113 | | 113 | 27 | 9 | 0 |
| Queue Length 95th (ft) | #230 | | 183 | 35 | 30 | 24 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 459 | | 737 | 1215 | 464 | 443 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.70 | | 0.77 | 0.18 | 0.06 | 0.09 |

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 65
Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green
Natural Cycle: 65
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 19.8 Intersection LOS: B
Intersection Capacity Utilization 59.8% ICU Level of Service B
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 133: Veteran's Way & Old Sandwich Road



| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 285 | 10 | 520 | 200 | 25 | 35 |
| Future Volume (vph) | 285 | 10 | 520 | 200 | 25 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1801 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.26 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1801 | | 474 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 310 | 11 | 565 | 217 | 27 | 38 |
| RTOR Reduction (vph) | 2 | 0 | 0 | 0 | 0 | 30 |
| Lane Group Flow (vph) | 319 | 0 | 565 | 217 | 27 | 8 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 15.5 | | 41.6 | 41.6 | 14.4 | 14.4 |
| Effective Green, g (s) | 15.5 | | 41.6 | 41.6 | 14.4 | 14.4 |
| Actuated g/C Ratio | 0.24 | | 0.64 | 0.64 | 0.22 | 0.22 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 429 | | 717 | 1158 | 380 | 340 |
| v/s Ratio Prot | 0.18 | | c0.26 | 0.12 | c0.02 | |
| v/s Ratio Perm | | | c0.24 | | | 0.01 |
| v/c Ratio | 0.74 | | 0.79 | 0.19 | 0.07 | 0.02 |
| Uniform Delay, d1 | 22.9 | | 9.9 | 4.8 | 20.0 | 19.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 6.8 | | 5.7 | 0.1 | 0.4 | 0.1 |
| Delay (s) | 29.7 | | 15.7 | 4.9 | 20.4 | 19.9 |
| Level of Service | C | | B | A | C | B |
| Approach Delay (s) | 29.7 | | | 12.7 | 20.1 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 17.8 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.63 | | |
| Actuated Cycle Length (s) | 65.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 59.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 285 | 10 | 520 | 200 | 25 | 35 |
| Future Volume (veh/h) | 285 | 10 | 520 | 200 | 25 | 35 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 310 | 11 | 565 | 217 | 27 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 371 | 13 | 630 | 1011 | 522 | 466 |
| Arrive On Green | 0.21 | 0.21 | 0.28 | 0.56 | 0.30 | 0.00 |
| Sat Flow, veh/h | 1737 | 62 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 321 | 565 | 217 | 27 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1799 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 11.1 | 15.2 | 3.9 | 0.7 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 11.1 | 15.2 | 3.9 | 0.7 | 0.0 |
| Prop In Lane | | 0.03 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 384 | 630 | 1011 | 522 | 466 |
| V/C Ratio(X) | 0.00 | 0.84 | 0.90 | 0.21 | 0.05 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 429 | 698 | 1127 | 522 | 466 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 0.76 | 0.76 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 24.5 | 13.0 | 7.2 | 16.0 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 12.4 | 10.7 | 0.1 | 0.2 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 6.8 | 8.9 | 2.0 | 0.4 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 36.8 | 23.7 | 7.3 | 16.2 | 0.0 |
| LnGrp LOS | | D | C | A | B | |
| Approach Vol, veh/h | 321 | | | 782 | 27 | |
| Approach Delay, s/veh | 36.8 | | | 19.1 | 16.2 | |
| Approach LOS | D | | | B | B | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 24.2 | 22.4 | 18.4 | | | | 40.8 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 15.5 | 20.5 | 15.5 | | | | 40.5 |
| Max Q Clear Time (g_c+I1), s | | 2.7 | 17.2 | 13.1 | | | | 5.9 |
| Green Ext Time (p_c), s | | 0.0 | 0.7 | 0.8 | | | | 3.6 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 24.1 |
| HCM 2010 LOS | | C |

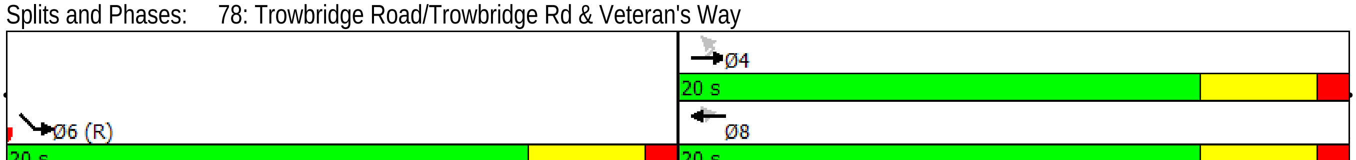
78: Trowbridge Road/Trowbridge Rd & Veteran's Way 02/19/2018

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 65 | 80 | 225 | 30 | 685 | 45 |
| Future Volume (vph) | 65 | 80 | 225 | 30 | 685 | 45 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.991 | |
| Flt Protected | | 0.978 | | | 0.955 | |
| Satd. Flow (prot) | 0 | 1770 | 1810 | 1538 | 3322 | 0 |
| Flt Permitted | | 0.755 | | | 0.955 | |
| Satd. Flow (perm) | 0 | 1366 | 1810 | 1538 | 3322 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 33 | 20 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 71 | 87 | 245 | 33 | 745 | 49 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 158 | 245 | 33 | 794 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | |
| Maximum Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 10.7 | 10.7 | 10.7 | 20.3 | |
| Actuated g/C Ratio | | 0.27 | 0.27 | 0.27 | 0.51 | |
| v/c Ratio | | 0.43 | 0.51 | 0.08 | 0.47 | |
| Control Delay | | 14.9 | 15.4 | 4.5 | 6.0 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 14.9 | 15.4 | 4.5 | 6.0 | |
| LOS | | B | B | A | A | |
| Approach Delay | | 14.9 | 14.1 | | 6.0 | |
| Approach LOS | | B | B | | A | |
| Queue Length 50th (ft) | | 29 | 46 | 0 | 68 | |
| Queue Length 95th (ft) | | 54 | 76 | 11 | m85 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 529 | 701 | 616 | 1695 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.30 | 0.35 | 0.05 | 0.47 | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 40 | |
| Actuated Cycle Length: 40 | |
| Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green | |
| Natural Cycle: 40 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.51 | |
| Intersection Signal Delay: 9.0 | Intersection LOS: A |
| Intersection Capacity Utilization 51.9% | ICU Level of Service A |
| Analysis Period (min) 15 | |
| m Volume for 95th percentile queue is metered by upstream signal. | |

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 65 | 80 | 225 | 30 | 685 | 45 |
| Future Volume (vph) | 65 | 80 | 225 | 30 | 685 | 45 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.99 | |
| Flt Protected | | 0.98 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (prot) | | 1770 | 1810 | 1538 | 3322 | |
| Flt Permitted | | 0.76 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (perm) | | 1367 | 1810 | 1538 | 3322 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 71 | 87 | 245 | 33 | 745 | 49 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 24 | 10 | 0 |
| Lane Group Flow (vph) | 0 | 158 | 245 | 9 | 784 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 10.7 | 10.7 | 10.7 | 20.3 | |
| Effective Green, g (s) | | 10.7 | 10.7 | 10.7 | 20.3 | |
| Actuated g/C Ratio | | 0.27 | 0.27 | 0.27 | 0.51 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 365 | 484 | 411 | 1685 | |
| v/s Ratio Prot | | | c0.14 | | c0.24 | |
| v/s Ratio Perm | | 0.12 | | 0.01 | | |
| v/c Ratio | | 0.43 | 0.51 | 0.02 | 0.47 | |
| Uniform Delay, d1 | | 12.1 | 12.4 | 10.8 | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 0.81 | |
| Incremental Delay, d2 | | 0.8 | 0.8 | 0.0 | 0.3 | |
| Delay (s) | | 13.0 | 13.2 | 10.8 | 5.5 | |
| Level of Service | | B | B | B | A | |
| Approach Delay (s) | | 13.0 | 13.0 | | 5.5 | |
| Approach LOS | | B | B | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 8.1 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 51.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 Computation does not support turning movement with Shared and Exclusive lanes.

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 495 | 20 | 1255 | 120 | 905 |
| Future Volume (vph) | 195 | 495 | 20 | 1255 | 120 | 905 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 0 |
| Storage Lanes | 1 | 0 | 0 | | | 0 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.892 | | | | 0.881 | |
| Flt Protected | 0.986 | | | 0.999 | | |
| Satd. Flow (prot) | 3088 | 0 | 0 | 3435 | 1594 | 0 |
| Flt Permitted | 0.986 | | | 0.861 | | |
| Satd. Flow (perm) | 3088 | 0 | 0 | 2960 | 1594 | 0 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 538 | | | | 838 | |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 538 | 22 | 1364 | 130 | 984 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 750 | 0 | 0 | 1386 | 1114 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | |
| Detector Template | Left | | Left | Thru | Thru | |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | |
| Total Split (s) | 20.0 | | 8.0 | 55.0 | 47.0 | |
| Total Split (%) | 26.7% | | 10.7% | 73.3% | 62.7% | |
| Maximum Green (s) | 15.5 | | 4.0 | 50.5 | 42.5 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | |
| Lead/Lag | | | Lead | | Lag | |
| Lead-Lag Optimize? | | | Yes | | Yes | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | | None | Min | Min | |
| Walk Time (s) | | | | | 7.0 | |
| Flash Dont Walk (s) | | | | | 11.0 | |
| Pedestrian Calls (#/hr) | | | | | 0 | |
| Act Effct Green (s) | 10.8 | | | 39.8 | 39.8 | |
| Actuated g/C Ratio | 0.18 | | | 0.66 | 0.66 | |
| v/c Ratio | 0.75 | | | 0.71 | 0.83 | |
| Control Delay | 13.0 | | | 9.2 | 9.0 | |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | |
| Total Delay | 13.0 | | | 9.2 | 9.0 | |
| LOS | B | | | A | A | |
| Approach Delay | 13.0 | | | 9.2 | 9.0 | |
| Approach LOS | B | | | A | A | |
| Queue Length 50th (ft) | 38 | | | 142 | 35 | |
| Queue Length 95th (ft) | 99 | | | 245 | 197 | |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | |
| Base Capacity (vph) | 1243 | | | 2443 | 1425 | |
| Starvation Cap Reductn | 0 | | | 0 | 0 | |
| Spillback Cap Reductn | 0 | | | 0 | 0 | |
| Storage Cap Reductn | 0 | | | 0 | 0 | |
| Reduced v/c Ratio | 0.60 | | | 0.57 | 0.78 | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 75 | |
| Actuated Cycle Length: 60.3 | |
| Natural Cycle: 75 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.83 | |
| Intersection Signal Delay: 10.0 | Intersection LOS: A |
| Intersection Capacity Utilization 90.9% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd

| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 195 | 495 | 20 | 1255 | 120 | 905 |
| Future Volume (vph) | 195 | 495 | 20 | 1255 | 120 | 905 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | |
| Frt | 0.89 | | | 1.00 | 0.88 | |
| Flt Protected | 0.99 | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3089 | | | 3435 | 1594 | |
| Flt Permitted | 0.99 | | | 0.86 | 1.00 | |
| Satd. Flow (perm) | 3089 | | | 2959 | 1594 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 538 | 22 | 1364 | 130 | 984 |
| RTOR Reduction (vph) | 441 | 0 | 0 | 0 | 278 | 0 |
| Lane Group Flow (vph) | 309 | 0 | 0 | 1386 | 836 | 0 |
| Turn Type | Prot | | pm+pt | NA | NA | |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | |
| Actuated Green, G (s) | 10.8 | | | 39.8 | 39.8 | |
| Effective Green, g (s) | 10.8 | | | 39.8 | 39.8 | |
| Actuated g/C Ratio | 0.18 | | | 0.67 | 0.67 | |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 559 | | | 1975 | 1064 | |
| v/s Ratio Prot | c0.10 | | | | | |
| v/s Ratio Perm | | | | 0.47 | c0.52 | |
| v/c Ratio | 0.55 | | | 0.70 | 0.79 | |
| Uniform Delay, d1 | 22.2 | | | 6.2 | 6.9 | |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1.2 | | | 1.1 | 3.9 | |
| Delay (s) | 23.4 | | | 7.3 | 10.8 | |
| Level of Service | C | | | A | B | |
| Approach Delay (s) | 23.4 | | | 7.3 | 10.8 | |
| Approach LOS | C | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.2 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 59.6 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 90.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 edition methodology does not support a perm + prot left-turn type from a shared lane. Left-turn bay is needed for phases 7.

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 610 | 10 | 720 | 205 | 25 | 80 |
| Future Volume (vph) | 610 | 10 | 720 | 205 | 25 | 80 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.998 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1806 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.138 | | 0.950 | |
| Satd. Flow (perm) | 1806 | 0 | 250 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 1 | | | | | 87 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 663 | 11 | 783 | 223 | 27 | 87 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 674 | 0 | 783 | 223 | 27 | 87 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 29.0 | | 30.0 | 59.0 | 21.0 | 21.0 |
| Total Split (%) | 36.3% | | 37.5% | 73.8% | 26.3% | 26.3% |
| Maximum Green (s) | 24.5 | | 25.5 | 54.5 | 16.5 | 16.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 24.5 | | 63.9 | 63.9 | 7.1 | 7.1 |
| Actuated g/C Ratio | 0.31 | | 0.80 | 0.80 | 0.09 | 0.09 |
| v/c Ratio | 1.22 | | 0.93 | 0.15 | 0.18 | 0.40 |
| Control Delay | 142.1 | | 36.7 | 2.3 | 31.0 | 17.3 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 142.1 | | 36.7 | 2.3 | 31.0 | 17.3 |
| LOS | F | | D | A | C | B |
| Approach Delay | 142.1 | | | 29.1 | 20.5 | |
| Approach LOS | F | | | C | C | |
| Queue Length 50th (ft) | ~422 | | 295 | 17 | 14 | 11 |
| Queue Length 95th (ft) | #628 | | #579 | 38 | 34 | 51 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 553 | | 841 | 1446 | 354 | 386 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.22 | | 0.93 | 0.15 | 0.08 | 0.23 |

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 4 (5%), Referenced to phase 2:NWL and 6:, Start of Green
Natural Cycle: 140
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.22
Intersection Signal Delay: 71.0 Intersection LOS: E
Intersection Capacity Utilization 88.0% ICU Level of Service E
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 133: Veteran's Way & Old Sandwich Road

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 610 | 10 | 720 | 205 | 25 | 80 |
| Future Volume (vph) | 610 | 10 | 720 | 205 | 25 | 80 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1806 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.14 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1806 | | 250 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 663 | 11 | 783 | 223 | 27 | 87 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 79 |
| Lane Group Flow (vph) | 673 | 0 | 783 | 223 | 27 | 8 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 24.5 | | 63.9 | 63.9 | 7.1 | 7.1 |
| Effective Green, g (s) | 24.5 | | 63.9 | 63.9 | 7.1 | 7.1 |
| Actuated g/C Ratio | 0.31 | | 0.80 | 0.80 | 0.09 | 0.09 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 553 | | 840 | 1445 | 152 | 136 |
| v/s Ratio Prot | c0.37 | | c0.41 | 0.12 | c0.02 | |
| v/s Ratio Perm | | | 0.34 | | | 0.01 |
| v/c Ratio | 1.22 | | 0.93 | 0.15 | 0.18 | 0.06 |
| Uniform Delay, d1 | 27.8 | | 17.3 | 1.8 | 33.7 | 33.4 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 0.86 | 1.37 |
| Incremental Delay, d2 | 113.6 | | 16.8 | 0.1 | 2.5 | 0.8 |
| Delay (s) | 141.3 | | 34.2 | 1.9 | 31.5 | 46.6 |
| Level of Service | F | | C | A | C | D |
| Approach Delay (s) | 141.3 | | | 27.0 | 43.0 | |
| Approach LOS | F | | | C | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 71.0 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.96 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 88.0% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 610 | 10 | 720 | 205 | 25 | 80 |
| Future Volume (veh/h) | 610 | 10 | 720 | 205 | 25 | 80 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 663 | 11 | 783 | 223 | 27 | 0 |
| Adj No. of Lanes | 1 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 544 | 9 | 639 | 1233 | 355 | 317 |
| Arrive On Green | 0.31 | 0.31 | 0.32 | 0.68 | 0.21 | 0.00 |
| Sat Flow, veh/h | 1775 | 29 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 0 | 674 | 783 | 223 | 27 | 0 |
| Grp Sat Flow(s),veh/h/ln | 0 | 1804 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 0.0 | 24.5 | 25.5 | 3.6 | 1.0 | 0.0 |
| Cycle Q Clear(g_c), s | 0.0 | 24.5 | 25.5 | 3.6 | 1.0 | 0.0 |
| Prop In Lane | | 0.02 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 0 | 553 | 639 | 1233 | 355 | 317 |
| V/C Ratio(X) | 0.00 | 1.22 | 1.22 | 0.18 | 0.08 | 0.00 |
| Avail Cap(c_a), veh/h | 0 | 553 | 639 | 1233 | 355 | 317 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 |
| Uniform Delay (d), s/veh | 0.0 | 27.8 | 21.5 | 4.6 | 25.6 | 0.0 |
| Incr Delay (d2), s/veh | 0.0 | 114.5 | 114.7 | 0.1 | 0.4 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 0.0 | 29.7 | 34.4 | 1.8 | 0.5 | 0.0 |
| LnGrp Delay(d),s/veh | 0.0 | 142.3 | 136.2 | 4.7 | 26.0 | 0.0 |
| LnGrp LOS | | F | F | A | C | |
| Approach Vol, veh/h | 674 | | | 1006 | 27 | |
| Approach Delay, s/veh | 142.3 | | | 107.0 | 26.0 | |
| Approach LOS | F | | | F | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 21.0 | 30.0 | 29.0 | | | | 59.0 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 16.5 | 25.5 | 24.5 | | | | 54.5 |
| Max Q Clear Time (g_c+I1), s | | 3.0 | 27.5 | 26.5 | | | | 5.6 |
| Green Ext Time (p_c), s | | 0.0 | 0.0 | 0.0 | | | | 7.5 |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 119.7 |
| HCM 2010 LOS | | | F |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | | ✣ | |
| Traffic Volume (veh/h) | 115 | 5 | 10 | 0 | 0 | 120 | 75 | 275 | 0 | 5 | 260 | 5 |
| Future Volume (Veh/h) | 115 | 5 | 10 | 0 | 0 | 120 | 75 | 275 | 0 | 5 | 260 | 5 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 125 | 5 | 11 | 0 | 0 | 130 | 82 | 299 | 0 | 5 | 283 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 758 | 756 | 299 | 761 | 758 | 286 | 283 | | | 299 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 758 | 756 | 299 | 761 | 758 | 286 | 283 | | | 299 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 51 | 98 | 99 | 100 | 100 | 83 | 94 | | | 100 | | |
| cM capacity (veh/h) | 254 | 314 | 741 | 297 | 313 | 754 | 1279 | | | 1262 | | |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | NW 1 |
|---|---|---|---|---|
| Volume Total | 141 | 130 | 381 | 293 |
| Volume Left | 125 | 0 | 82 | 5 |
| Volume Right | 11 | 130 | 0 | 5 |
| cSH | 269 | 754 | 1279 | 1262 |
| Volume to Capacity | 0.52 | 0.17 | 0.06 | 0.00 |
| Queue Length 95th (ft) | 70 | 16 | 5 | 0 |
| Control Delay (s) | 32.2 | 10.8 | 2.2 | 0.2 |
| Lane LOS | D | B | A | A |
| Approach Delay (s) | 32.2 | 10.8 | 2.2 | 0.2 |
| Approach LOS | D | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.2 | | |
| Intersection Capacity Utilization | 56.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Future Volume (vph) | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.991 | | | 0.865 | | | | | | 0.998 | |
| Flt Protected | | 0.957 | | | | | | 0.990 | | | 0.999 | |
| Satd. Flow (prot) | 0 | 1767 | 0 | 0 | 1611 | 0 | 0 | 1844 | 0 | 0 | 1857 | 0 |
| Flt Permitted | | 0.957 | | | | | | 0.990 | | | 0.999 | |
| Satd. Flow (perm) | 0 | 1767 | 0 | 0 | 1611 | 0 | 0 | 1844 | 0 | 0 | 1857 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 220 | | | 345 | | | 326 | | | 645 | |
| Travel Time (s) | | 5.0 | | | 7.8 | | | 7.4 | | | 14.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 152 | 5 | 11 | 0 | 0 | 141 | 92 | 353 | 0 | 5 | 364 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 168 | 0 | 0 | 141 | 0 | 0 | 445 | 0 | 0 | 374 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 70.0% ICU Level of Service C

Analysis Period (min) 15

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Future Volume (Veh/h) | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 152 | 5 | 11 | 0 | 0 | 141 | 92 | 353 | 0 | 5 | 364 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 914 | 911 | 353 | 916 | 914 | 366 | 364 | | | 353 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 914 | 911 | 353 | 916 | 914 | 366 | 364 | | | 353 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 19 | 98 | 98 | 100 | 100 | 79 | 92 | | | 100 | | |
| cM capacity (veh/h) | 189 | 252 | 691 | 230 | 251 | 679 | 1195 | | | 1206 | | |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | NW 1 |
|---|---|---|---|---|
| Volume Total | 168 | 141 | 445 | 374 |
| Volume Left | 152 | 0 | 92 | 5 |
| Volume Right | 11 | 141 | 0 | 5 |
| cSH | 200 | 679 | 1195 | 1206 |
| Volume to Capacity | 0.84 | 0.21 | 0.08 | 0.00 |
| Queue Length 95th (ft) | 155 | 19 | 6 | 0 |
| Control Delay (s) | 77.2 | 11.7 | 2.3 | 0.1 |
| Lane LOS | F | B | A | A |
| Approach Delay (s) | 77.2 | 11.7 | 2.3 | 0.1 |
| Approach LOS | F | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 13.9 | | |
| Intersection Capacity Utilization | 70.0% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | | ✣ | |
| Traffic Vol, veh/h | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Future Vol, veh/h | 140 | 5 | 10 | 0 | 0 | 130 | 85 | 325 | 0 | 5 | 335 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Free | Free | Free | Free | Free | Free |
| RT Channelized | - | - | Free | - | - | Free | - | - | Free | - | - | Free |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 152 | 5 | 11 | 0 | 0 | 141 | 92 | 353 | 0 | 5 | 364 | 5 |

| Major/Minor | Minor1 | | | Minor2 | | | Major1 | | | Major2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 913 | 913 | - | 916 | 913 | - | 364 | 0 | - | 353 | 0 | 0 |
| Stage 1 | 538 | 538 | - | 375 | 375 | - | - | - | - | - | - | - |
| Stage 2 | 375 | 375 | - | 541 | 538 | - | - | - | - | - | - | - |
| Critical Hdwy | 7.12 | 6.52 | - | 7.12 | 6.52 | - | 4.12 | - | - | 4.12 | - | - |
| Critical Hdwy Stg 1 | 6.12 | 5.52 | - | 6.12 | 5.52 | - | - | - | - | - | - | - |
| Critical Hdwy Stg 2 | 6.12 | 5.52 | - | 6.12 | 5.52 | - | - | - | - | - | - | - |
| Follow-up Hdwy | 3.518 | 4.018 | - | 3.518 | 4.018 | - | 2.218 | - | - | 2.218 | - | - |
| Pot Cap-1 Maneuver | 254 | 273 | 0 | 253 | 273 | 0 | 1195 | - | 0 | 1206 | - | 0 |
| Stage 1 | 527 | 522 | 0 | 646 | 617 | 0 | - | - | 0 | - | - | 0 |
| Stage 2 | 646 | 617 | 0 | 525 | 522 | 0 | - | - | 0 | - | - | 0 |
| Platoon blocked, % | | | | | | | | - | | | - | |
| Mov Cap-1 Maneuver | 234 | 246 | - | 230 | 246 | - | 1195 | - | - | 1206 | - | - |
| Mov Cap-2 Maneuver | 234 | 246 | - | 230 | 246 | - | - | - | - | - | - | - |
| Stage 1 | 476 | 472 | - | 584 | 614 | - | - | - | - | - | - | - |
| Stage 2 | 643 | 614 | - | 469 | 472 | - | - | - | - | - | - | - |

| Approach | EB | WB | SE | NW |
|---|---|---|---|---|
| HCM Control Delay, s | | 0 | 1.7 | 0.1 |
| HCM LOS | - | A | | |

| Minor Lane/Major Mvmt | NWL | NWT | EBLn1 | WBLn1 | SEL | SET |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 1206 | - | - | - | 1195 | - |
| HCM Lane V/C Ratio | 0.005 | - | - | - | 0.077 | - |
| HCM Control Delay (s) | 8 | 0 | - | 0 | 8.3 | 0 |
| HCM Lane LOS | A | A | - | A | A | A |
| HCM 95th %tile Q(veh) | 0 | - | - | - | 0.3 | - |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 280 | 10 | 30 | 5 | 5 | 265 | 95 | 290 | 0 | 5 | 600 | 15 |
| Future Volume (Veh/h) | 280 | 10 | 30 | 5 | 5 | 265 | 95 | 290 | 0 | 5 | 600 | 15 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 304 | 11 | 33 | 5 | 5 | 288 | 103 | 315 | 0 | 5 | 652 | 16 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1194 | 1183 | 315 | 1196 | 1191 | 660 | 652 | | | 315 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1194 | 1183 | 315 | 1196 | 1191 | 660 | 652 | | | 315 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 0 | 93 | 95 | 96 | 97 | 38 | 89 | | | 100 | | |
| cM capacity (veh/h) | 55 | 168 | 725 | 135 | 166 | 463 | 935 | | | 1245 | | |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | NW 1 |
|---|---|---|---|---|
| Volume Total | 348 | 298 | 418 | 673 |
| Volume Left | 304 | 5 | 103 | 5 |
| Volume Right | 33 | 288 | 0 | 16 |
| cSH | 62 | 432 | 935 | 1245 |
| Volume to Capacity | 5.62 | 0.69 | 0.11 | 0.00 |
| Queue Length 95th (ft) | Err | 128 | 9 | 0 |
| Control Delay (s) | Err | 29.8 | 3.2 | 0.1 |
| Lane LOS | F | D | A | A |
| Approach Delay (s) | Err | 29.8 | 3.2 | 0.1 |
| Approach LOS | F | D | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2009.2 | | |
| Intersection Capacity Utilization | 101.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

Lanes, Volumes, Timings
137: Rte 6A & Main St/Tupper Rd 02/06/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Future Volume (vph) | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.987 | | | 0.869 | | | | | | 0.996 | |
| Flt Protected | | 0.958 | | | 0.999 | | | 0.987 | | | | |
| Satd. Flow (prot) | 0 | 1761 | 0 | 0 | 1617 | 0 | 0 | 1839 | 0 | 0 | 1855 | 0 |
| Flt Permitted | | 0.958 | | | 0.999 | | | 0.987 | | | | |
| Satd. Flow (perm) | 0 | 1761 | 0 | 0 | 1617 | 0 | 0 | 1839 | 0 | 0 | 1855 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 220 | | | 315 | | | 326 | | | 645 | |
| Travel Time (s) | | 5.0 | | | 7.2 | | | 7.4 | | | 14.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 359 | 11 | 38 | 5 | 5 | 326 | 130 | 375 | 0 | 5 | 739 | 22 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 408 | 0 | 0 | 336 | 0 | 0 | 505 | 0 | 0 | 766 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 115.4% | ICU Level of Service H |
| Analysis Period (min) 15 | |

HCM Unsignalized Intersection Capacity Analysis
137: Rte 6A & Main St/Tupper Rd 02/06/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Future Volume (Veh/h) | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 359 | 11 | 38 | 5 | 5 | 326 | 130 | 375 | 0 | 5 | 739 | 22 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1398 | 1384 | 375 | 1400 | 1395 | 750 | 739 | | | 375 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1398 | 1384 | 375 | 1400 | 1395 | 750 | 739 | | | 375 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 0 | 91 | 94 | 95 | 96 | 21 | 85 | | | 100 | | |
| cM capacity (veh/h) | 21 | 121 | 671 | 91 | 120 | 411 | 867 | | | 1183 | | |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | NW 1 |
|---|---|---|---|---|
| Volume Total | 408 | 336 | 505 | 766 |
| Volume Left | 359 | 5 | 130 | 5 |
| Volume Right | 38 | 326 | 0 | 22 |
| cSH | 24 | 378 | 867 | 1183 |
| Volume to Capacity | 17.27 | 0.89 | 0.15 | 0.00 |
| Queue Length 95th (ft) | Err | 223 | 13 | 0 |
| Control Delay (s) | Err | 56.2 | 4.0 | 0.1 |
| Lane LOS | F | F | A | A |
| Approach Delay (s) | Err | 56.2 | 4.0 | 0.1 |
| Approach LOS | F | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2035.0 | | |
| Intersection Capacity Utilization | 115.4% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.9 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Future Vol, veh/h | 330 | 10 | 35 | 5 | 5 | 300 | 120 | 345 | 0 | 5 | 680 | 20 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Free | Free | Free | Free | Free | Free |
| RT Channelized | - | - | Free | - | - | Free | - | - | Free | - | - | Free |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mvmt Flow | 359 | 11 | 38 | 5 | 5 | 326 | 130 | 375 | 0 | 5 | 739 | 22 |

| Major/Minor | Minor1 | | | Minor2 | | | Major1 | | | Major2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 1389 | 1386 | - | 1391 | 1386 | - | 739 | 0 | - | 375 | 0 | 0 |
| Stage 1 | 636 | 636 | - | 750 | 750 | - | - | - | - | - | - | - |
| Stage 2 | 753 | 750 | - | 641 | 636 | - | - | - | - | - | - | - |
| Critical Hdwy | 7.12 | 6.52 | - | 7.12 | 6.52 | - | 4.12 | - | - | 4.12 | - | - |
| Critical Hdwy Stg 1 | 6.12 | 5.52 | - | 6.12 | 5.52 | - | - | - | - | - | - | - |
| Critical Hdwy Stg 2 | 6.12 | 5.52 | - | 6.12 | 5.52 | - | - | - | - | - | - | - |
| Follow-up Hdwy | 3.518 | 4.018 | - | 3.518 | 4.018 | - | 2.218 | - | - | 2.218 | - | - |
| Pot Cap-1 Maneuver | ~ 120 | 143 | 0 | 120 | 143 | 0 | 867 | - | 0 | 1183 | - | 0 |
| Stage 1 | 466 | 472 | 0 | 403 | 419 | 0 | - | - | 0 | - | - | 0 |
| Stage 2 | 402 | 419 | 0 | 463 | 472 | 0 | - | - | 0 | - | - | 0 |
| Platoon blocked, % | | | | | | | | - | | | - | |
| Mov Cap-1 Maneuver | ~ 98 | 115 | - | 95 | 115 | - | 867 | - | - | 1183 | - | - |
| Mov Cap-2 Maneuver | ~ 98 | 115 | - | 95 | 115 | - | - | - | - | - | - | - |
| Stage 1 | 378 | 383 | - | 327 | 416 | - | - | - | - | - | - | - |
| Stage 2 | 394 | 416 | - | 365 | 383 | - | - | - | - | - | - | - |

| Approach | EB | WB | SE | NW |
|---|---|---|---|---|
| HCM Control Delay, s | | | 2.6 | 0.1 |
| HCM LOS | - | - | | |

| Minor Lane/Major Mvmt | NWL | NWT | EBLn1 | WBLn1 | SEL | SET |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 1183 | - | - | - | 867 | - |
| HCM Lane V/C Ratio | 0.005 | - | - | - | 0.15 | - |
| HCM Control Delay (s) | 8.1 | 0 | - | - | 9.9 | 0 |
| HCM Lane LOS | A | A | - | - | A | A |
| HCM 95th %tile Q(veh) | 0 | - | - | - | 0.5 | - |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 1025 | 305 |
| Future Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 1025 | 305 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.920 | | | 0.955 | | | 0.962 | | | | 0.850 |
| Flt Protected | 0.950 | 0.978 | | | 0.984 | | 0.950 | | | | | |
| Satd. Flow (prot) | 1633 | 1547 | 0 | 0 | 1700 | 0 | 1719 | 1741 | 0 | 0 | 3438 | 1538 |
| Flt Permitted | 0.683 | 0.808 | | | 0.651 | | 0.123 | | | | 0.953 | |
| Satd. Flow (perm) | 1174 | 1278 | 0 | 0 | 1125 | 0 | 223 | 1741 | 0 | 0 | 3277 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 77 | | | 11 | | | 11 | | | | 235 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1054 | 11 | 370 | 11 | 11 | 11 | 435 | 33 | 11 | 11 | 1114 | 332 |
| Shared Lane Traffic (%) | 30% | | | | | | | | | | | |
| Lane Group Flow (vph) | 738 | 697 | 0 | 0 | 33 | 0 | 435 | 44 | 0 | 0 | 1125 | 332 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 19.0 | 41.5 | | 22.5 | 22.5 | | 16.0 | 48.5 | | 32.5 | 32.5 | 19.0 |
| Total Split (%) | 21.1% | 46.1% | | 25.0% | 25.0% | | 17.8% | 53.9% | | 36.1% | 36.1% | 21.1% |
| Maximum Green (s) | 14.5 | 37.0 | | 18.0 | 18.0 | | 11.5 | 44.0 | | 28.0 | 28.0 | 14.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 37.0 | 37.0 | | | 13.0 | | 44.0 | 44.0 | | | 28.0 | 56.0 |
| Actuated g/C Ratio | 0.41 | 0.41 | | | 0.14 | | 0.49 | 0.49 | | | 0.31 | 0.62 |
| v/c Ratio | 1.23 | 1.09 | | | 0.19 | | 1.45 | 0.05 | | | 1.10 | 0.32 |
| Control Delay | 142.8 | 87.1 | | | 25.4 | | 243.3 | 10.0 | | | 92.2 | 4.5 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 142.8 | 87.1 | | | 25.4 | | 243.3 | 10.0 | | | 92.2 | 4.5 |
| LOS | F | F | | | C | | F | A | | | F | A |
| Approach Delay | | 115.7 | | | 25.4 | | | 221.8 | | | 72.2 | |
| Approach LOS | | F | | | C | | | F | | | E | |
| Queue Length 50th (ft) | ~577 | ~463 | | | 10 | | ~294 | 9 | | | ~386 | 27 |
| Queue Length 95th (ft) | #806 | #692 | | | 36 | | #480 | 27 | | | #514 | 73 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 602 | 641 | | | 233 | | 300 | 856 | | | 1019 | 1045 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.23 | 1.09 | | | 0.14 | | 1.45 | 0.05 | | | 1.10 | 0.32 |

Intersection Summary

Area Type: Other

Cycle Length: 90

Actuated Cycle Length: 90

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.45

Intersection Signal Delay: 111.1 Intersection LOS: F

Intersection Capacity Utilization 106.2% ICU Level of Service G

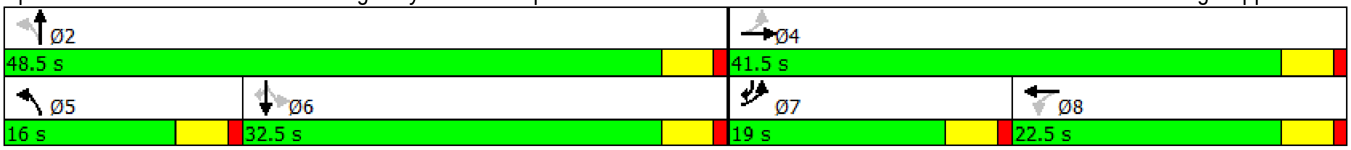
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 1025 | 305 |
| Future Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 1025 | 305 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 1.00 | 1.00 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 0.96 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 1.00 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1547 | | | 1700 | | 1719 | 1742 | | | 3436 | 1538 |
| Flt Permitted | 0.68 | 0.81 | | | 0.65 | | 0.12 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1174 | 1279 | | | 1125 | | 223 | 1742 | | | 3277 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1054 | 11 | 370 | 11 | 11 | 11 | 435 | 33 | 11 | 11 | 1114 | 332 |
| RTOR Reduction (vph) | 0 | 44 | 0 | 0 | 10 | 0 | 0 | 6 | 0 | 0 | 0 | 103 |
| Lane Group Flow (vph) | 738 | 653 | 0 | 0 | 23 | 0 | 435 | 38 | 0 | 0 | 1125 | 229 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 38.8 | 38.8 | | | 10.8 | | 44.0 | 44.0 | | | 28.0 | 51.5 |
| Effective Green, g (s) | 38.8 | 38.8 | | | 10.8 | | 44.0 | 44.0 | | | 28.0 | 51.5 |
| Actuated g/C Ratio | 0.42 | 0.42 | | | 0.12 | | 0.48 | 0.48 | | | 0.31 | 0.56 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 613 | 609 | | | 132 | | 294 | 834 | | | 999 | 938 |
| v/s Ratio Prot | c0.31 | 0.27 | | | | | c0.19 | 0.02 | | | | 0.06 |
| v/s Ratio Perm | c0.20 | 0.18 | | | 0.02 | | c0.52 | | | | 0.34 | 0.09 |
| v/c Ratio | 1.20 | 1.07 | | | 0.18 | | 1.48 | 0.05 | | | 1.13 | 0.24 |
| Uniform Delay, d1 | 25.7 | 26.5 | | | 36.5 | | 25.2 | 12.7 | | | 31.9 | 10.2 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 106.7 | 57.1 | | | 0.6 | | 233.3 | 0.0 | | | 69.8 | 0.1 |
| Delay (s) | 132.4 | 83.6 | | | 37.1 | | 258.5 | 12.7 | | | 101.7 | 10.4 |
| Level of Service | F | F | | | D | | F | B | | | F | B |
| Approach Delay (s) | | 108.7 | | | 37.1 | | | 236.0 | | | 80.9 | |
| Approach LOS | | F | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 114.0 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.47 | | |
| Actuated Cycle Length (s) | 91.8 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 106.2% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 5 | 295 | 355 | 225 | 395 | 70 |
| Future Volume (vph) | 5 | 295 | 355 | 225 | 395 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.948 | | 0.980 | |
| Flt Protected | | 0.999 | | | 0.959 | |
| Satd. Flow (prot) | 0 | 1808 | 1715 | 0 | 1701 | 0 |
| Flt Permitted | | 0.999 | | | 0.959 | |
| Satd. Flow (perm) | 0 | 1808 | 1715 | 0 | 1701 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 321 | 386 | 245 | 429 | 76 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 326 | 631 | 0 | 505 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 65.2% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 5 | 295 | 355 | 225 | 395 | 70 |
| Future Volume (Veh/h) | 5 | 295 | 355 | 225 | 395 | 70 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 321 | 386 | 245 | 429 | 76 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 631 | | | | 840 | 508 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 631 | | | | 840 | 508 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 0 | 86 |
| cM capacity (veh/h) | 937 | | | | 330 | 559 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 326 | 631 | 505 |
| Volume Left | 5 | 0 | 429 |
| Volume Right | 0 | 245 | 76 |
| cSH | 937 | 1700 | 352 |
| Volume to Capacity | 0.01 | 0.37 | 1.44 |
| Queue Length 95th (ft) | 0 | 0 | 659 |
| Control Delay (s) | 0.2 | 0.0 | 241.0 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.2 | 0.0 | 241.0 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 83.3 | | |
| Intersection Capacity Utilization | 65.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1015 | 0 | 0 | 520 |
| Future Volume (vph) | 0 | 0 | 1015 | 0 | 0 | 520 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1103 | 0 | 0 | 565 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1103 | 0 | 0 | 565 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 56.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

Intersection Sign configuration not allowed in HCM analysis.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 995 | 310 |
| Future Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 995 | 310 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.920 | | | 0.955 | | | 0.993 | | | | 0.850 |
| Flt Protected | 0.950 | 0.978 | | | 0.984 | | 0.950 | 0.960 | | | 0.999 | |
| Satd. Flow (prot) | 1633 | 1547 | 0 | 0 | 1700 | 0 | 1633 | 1639 | 0 | 0 | 3435 | 1538 |
| Flt Permitted | 0.683 | 0.808 | | | 0.555 | | 0.106 | 0.096 | | | 0.951 | |
| Satd. Flow (perm) | 1174 | 1278 | 0 | 0 | 959 | 0 | 182 | 164 | 0 | 0 | 3270 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 75 | | | 11 | | | 4 | | | | 273 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1054 | 11 | 370 | 11 | 11 | 11 | 435 | 33 | 11 | 11 | 1082 | 337 |
| Shared Lane Traffic (%) | 30% | | | | | | 47% | | | | | |
| Lane Group Flow (vph) | 738 | 697 | 0 | 0 | 33 | 0 | 231 | 248 | 0 | 0 | 1093 | 337 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

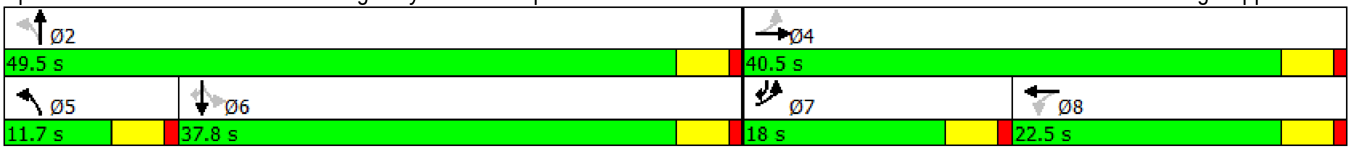
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 18.0 | 40.5 | | 22.5 | 22.5 | | 11.7 | 49.5 | | 37.8 | 37.8 | 18.0 |
| Total Split (%) | 20.0% | 45.0% | | 25.0% | 25.0% | | 13.0% | 55.0% | | 42.0% | 42.0% | 20.0% |
| Maximum Green (s) | 13.5 | 36.0 | | 18.0 | 18.0 | | 7.2 | 45.0 | | 33.3 | 33.3 | 13.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 36.0 | 36.0 | | | 13.0 | | 45.0 | 45.0 | | | 33.3 | 60.3 |
| Actuated g/C Ratio | 0.40 | 0.40 | | | 0.14 | | 0.50 | 0.50 | | | 0.37 | 0.67 |
| v/c Ratio | 1.26 | 1.12 | | | 0.22 | | 1.12 | 1.23 | | | 0.90 | 0.30 |
| Control Delay | 158.9 | 99.0 | | | 26.6 | | 119.2 | 161.0 | | | 38.9 | 3.0 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 158.9 | 99.0 | | | 26.6 | | 119.2 | 161.0 | | | 38.9 | 3.0 |
| LOS | F | F | | | C | | F | F | | | D | A |
| Approach Delay | | 129.8 | | | 26.6 | | | 140.9 | | | 30.4 | |
| Approach LOS | | F | | | C | | | F | | | C | |
| Queue Length 50th (ft) | ~589 | ~474 | | | 10 | | ~110 | ~140 | | | 304 | 15 |
| Queue Length 95th (ft) | #817 | #704 | | | 36 | | #264 | #297 | | | #432 | 53 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 584 | 623 | | | 200 | | 207 | 202 | | | 1209 | 1120 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.26 | 1.12 | | | 0.17 | | 1.12 | 1.23 | | | 0.90 | 0.30 |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.26
Intersection Signal Delay: 88.3 Intersection LOS: F
Intersection Capacity Utilization 95.4% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



HCM Signalized Intersection Capacity Analysis
117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridg 02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 995 | 310 |
| Future Volume (vph) | 970 | 10 | 340 | 10 | 10 | 10 | 400 | 30 | 10 | 10 | 995 | 310 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 0.95 | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 0.99 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 0.96 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1547 | | | 1700 | | 1633 | 1640 | | | 3436 | 1538 |
| Flt Permitted | 0.68 | 0.81 | | | 0.55 | | 0.11 | 0.10 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1174 | 1279 | | | 959 | | 182 | 165 | | | 3271 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1054 | 11 | 370 | 11 | 11 | 11 | 435 | 33 | 11 | 11 | 1082 | 337 |
| RTOR Reduction (vph) | 0 | 44 | 0 | 0 | 10 | 0 | 0 | 2 | 0 | 0 | 0 | 107 |
| Lane Group Flow (vph) | 738 | 653 | 0 | 0 | 23 | 0 | 231 | 246 | 0 | 0 | 1093 | 230 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 37.8 | 37.8 | | | 10.8 | | 45.0 | 45.0 | | | 33.3 | 55.8 |
| Effective Green, g (s) | 37.8 | 37.8 | | | 10.8 | | 45.0 | 45.0 | | | 33.3 | 55.8 |
| Actuated g/C Ratio | 0.41 | 0.41 | | | 0.12 | | 0.49 | 0.49 | | | 0.36 | 0.61 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 595 | 592 | | | 112 | | 203 | 196 | | | 1186 | 1010 |
| v/s Ratio Prot | c0.30 | 0.27 | | | | | 0.09 | c0.10 | | | | 0.06 |
| v/s Ratio Perm | c0.21 | 0.18 | | | 0.02 | | 0.47 | c0.52 | | | 0.33 | 0.09 |
| v/c Ratio | 1.24 | 1.10 | | | 0.21 | | 1.14 | 1.25 | | | 0.92 | 0.23 |
| Uniform Delay, d1 | 26.3 | 27.0 | | | 36.6 | | 21.8 | 23.4 | | | 28.0 | 8.2 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 122.0 | 68.4 | | | 0.9 | | 105.2 | 149.4 | | | 11.7 | 0.1 |
| Delay (s) | 148.3 | 95.4 | | | 37.6 | | 127.0 | 172.8 | | | 39.7 | 8.3 |
| Level of Service | F | F | | | D | | F | F | | | D | A |
| Approach Delay (s) | | 122.6 | | | 37.6 | | | 150.7 | | | 32.3 | |
| Approach LOS | | F | | | D | | | F | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 87.5 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.36 | | |
| Actuated Cycle Length (s) | 91.8 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 95.4% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 5 | 300 | 355 | 225 | 395 | 70 |
| Future Volume (vph) | 5 | 300 | 355 | 225 | 395 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.948 | | 0.980 | |
| Flt Protected | | 0.999 | | | 0.959 | |
| Satd. Flow (prot) | 0 | 1808 | 1715 | 0 | 1701 | 0 |
| Flt Permitted | | 0.999 | | | 0.959 | |
| Satd. Flow (perm) | 0 | 1808 | 1715 | 0 | 1701 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 326 | 386 | 245 | 429 | 76 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 331 | 631 | 0 | 505 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 65.2% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 5 | 300 | 355 | 225 | 395 | 70 |
| Future Volume (Veh/h) | 5 | 300 | 355 | 225 | 395 | 70 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 326 | 386 | 245 | 429 | 76 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 631 | | | | 844 | 508 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 631 | | | | 844 | 508 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 0 | 86 |
| cM capacity (veh/h) | 937 | | | | 328 | 559 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 331 | 631 | 505 |
| Volume Left | 5 | 0 | 429 |
| Volume Right | 0 | 245 | 76 |
| cSH | 937 | 1700 | 349 |
| Volume to Capacity | 0.01 | 0.37 | 1.45 |
| Queue Length 95th (ft) | 0 | 0 | 664 |
| Control Delay (s) | 0.2 | 0.0 | 244.9 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.2 | 0.0 | 244.9 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 84.4 | | |
| Intersection Capacity Utilization | 65.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1005 | 0 | 0 | 530 |
| Future Volume (vph) | 0 | 0 | 1005 | 0 | 0 | 530 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1092 | 0 | 0 | 576 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1092 | 0 | 0 | 576 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 56.2% | ICU Level of Service B |
| Analysis Period (min) 15 | |

Intersection Sign configuration not allowed in HCM analysis.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 965 | 10 | 330 | 10 | 10 | 10 | 370 | 30 | 10 | 10 | 980 | 310 |
| Future Volume (vph) | 965 | 10 | 330 | 10 | 10 | 10 | 370 | 30 | 10 | 10 | 980 | 310 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.921 | | | 0.955 | | | 0.993 | | | | 0.850 |
| Flt Protected | 0.950 | 0.978 | | | 0.984 | | 0.950 | 0.961 | | | 0.999 | |
| Satd. Flow (prot) | 1633 | 1548 | 0 | 0 | 1700 | 0 | 1633 | 1640 | 0 | 0 | 3435 | 1538 |
| Flt Permitted | 0.683 | 0.806 | | | 0.618 | | 0.105 | 0.095 | | | 0.951 | |
| Satd. Flow (perm) | 1174 | 1276 | 0 | 0 | 1068 | 0 | 180 | 162 | 0 | 0 | 3270 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 73 | | | 11 | | | 4 | | | | 279 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1049 | 11 | 359 | 11 | 11 | 11 | 402 | 33 | 11 | 11 | 1065 | 337 |
| Shared Lane Traffic (%) | 30% | | | | | | 47% | | | | | |
| Lane Group Flow (vph) | 734 | 685 | 0 | 0 | 33 | 0 | 213 | 233 | 0 | 0 | 1076 | 337 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

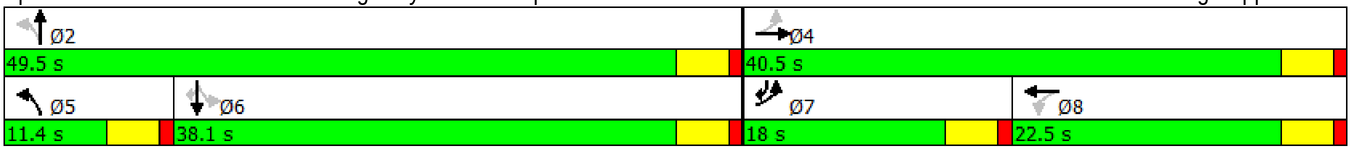
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 18.0 | 40.5 | | 22.5 | 22.5 | | 11.4 | 49.5 | | 38.1 | 38.1 | 18.0 |
| Total Split (%) | 20.0% | 45.0% | | 25.0% | 25.0% | | 12.7% | 55.0% | | 42.3% | 42.3% | 20.0% |
| Maximum Green (s) | 13.5 | 36.0 | | 18.0 | 18.0 | | 6.9 | 45.0 | | 33.6 | 33.6 | 13.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 36.0 | 36.0 | | | 13.0 | | 45.0 | 45.0 | | | 33.6 | 60.6 |
| Actuated g/C Ratio | 0.40 | 0.40 | | | 0.14 | | 0.50 | 0.50 | | | 0.37 | 0.67 |
| v/c Ratio | 1.26 | 1.10 | | | 0.20 | | 1.06 | 1.19 | | | 0.88 | 0.30 |
| Control Delay | 156.1 | 92.6 | | | 25.8 | | 102.2 | 147.3 | | | 36.5 | 2.8 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 156.1 | 92.6 | | | 25.8 | | 102.2 | 147.3 | | | 36.5 | 2.8 |
| LOS | F | F | | | C | | F | F | | | D | A |
| Approach Delay | | 125.4 | | | 25.8 | | | 125.8 | | | 28.5 | |
| Approach LOS | | F | | | C | | | F | | | C | |
| Queue Length 50th (ft) | ~584 | ~461 | | | 10 | | ~91 | ~124 | | | 295 | 14 |
| Queue Length 95th (ft) | #811 | #687 | | | 36 | | #241 | #278 | | | #417 | 51 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 584 | 622 | | | 222 | | 201 | 196 | | | 1220 | 1126 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.26 | 1.10 | | | 0.15 | | 1.06 | 1.19 | | | 0.88 | 0.30 |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Natural Cycle: 140
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.26
Intersection Signal Delay: 83.1 Intersection LOS: F
Intersection Capacity Utilization 93.7% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



## HCM Signalized Intersection Capacity Analysis

### 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridg

02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 965 | 10 | 330 | 10 | 10 | 10 | 370 | 30 | 10 | 10 | 980 | 310 |
| Future Volume (vph) | 965 | 10 | 330 | 10 | 10 | 10 | 370 | 30 | 10 | 10 | 980 | 310 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 0.95 | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 0.99 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 0.96 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1548 | | | 1700 | | 1633 | 1640 | | | 3436 | 1538 |
| Flt Permitted | 0.68 | 0.81 | | | 0.62 | | 0.10 | 0.10 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1174 | 1277 | | | 1068 | | 180 | 162 | | | 3271 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1049 | 11 | 359 | 11 | 11 | 11 | 402 | 33 | 11 | 11 | 1065 | 337 |
| RTOR Reduction (vph) | 0 | 43 | 0 | 0 | 10 | 0 | 0 | 2 | 0 | 0 | 0 | 109 |
| Lane Group Flow (vph) | 734 | 642 | 0 | 0 | 23 | 0 | 213 | 231 | 0 | 0 | 1076 | 229 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 37.8 | 37.8 | | | 10.8 | | 45.0 | 45.0 | | | 33.6 | 56.1 |
| Effective Green, g (s) | 37.8 | 37.8 | | | 10.8 | | 45.0 | 45.0 | | | 33.6 | 56.1 |
| Actuated g/C Ratio | 0.41 | 0.41 | | | 0.12 | | 0.49 | 0.49 | | | 0.37 | 0.61 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 595 | 592 | | | 125 | | 197 | 190 | | | 1197 | 1015 |
| v/s Ratio Prot | c0.30 | 0.27 | | | | | 0.08 | c0.09 | | | | 0.06 |
| v/s Ratio Perm | c0.21 | 0.18 | | | 0.02 | | 0.45 | c0.50 | | | 0.33 | 0.09 |
| v/c Ratio | 1.23 | 1.08 | | | 0.19 | | 1.08 | 1.22 | | | 0.90 | 0.23 |
| Uniform Delay, d1 | 26.3 | 27.0 | | | 36.5 | | 21.2 | 23.4 | | | 27.5 | 8.0 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 119.2 | 62.0 | | | 0.7 | | 87.4 | 135.3 | | | 9.2 | 0.1 |
| Delay (s) | 145.5 | 89.0 | | | 37.3 | | 108.6 | 158.7 | | | 36.7 | 8.2 |
| Level of Service | F | F | | | D | | F | F | | | D | A |
| Approach Delay (s) | | 118.2 | | | 37.3 | | | 134.8 | | | 29.9 | |
| Approach LOS | | F | | | D | | | F | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 81.9 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.33 | | |
| Actuated Cycle Length (s) | 91.8 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 93.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 5 | 290 | 350 | 205 | 395 | 70 |
| Future Volume (vph) | 5 | 290 | 350 | 205 | 395 | 70 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.950 | | 0.980 | |
| Flt Protected | | 0.999 | | | 0.959 | |
| Satd. Flow (prot) | 0 | 1808 | 1719 | 0 | 1701 | 0 |
| Flt Permitted | | 0.999 | | | 0.959 | |
| Satd. Flow (perm) | 0 | 1808 | 1719 | 0 | 1701 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 315 | 380 | 223 | 429 | 76 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 320 | 603 | 0 | 505 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 63.7% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 5 | 290 | 350 | 205 | 395 | 70 |
| Future Volume (Veh/h) | 5 | 290 | 350 | 205 | 395 | 70 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 315 | 380 | 223 | 429 | 76 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 603 | | | | 816 | 492 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 603 | | | | 816 | 492 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 0 | 87 |
| cM capacity (veh/h) | 960 | | | | 340 | 571 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 320 | 603 | 505 |
| Volume Left | 5 | 0 | 429 |
| Volume Right | 0 | 223 | 76 |
| cSH | 960 | 1700 | 362 |
| Volume to Capacity | 0.01 | 0.35 | 1.39 |
| Queue Length 95th (ft) | 0 | 0 | 633 |
| Control Delay (s) | 0.2 | 0.0 | 221.9 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.2 | 0.0 | 221.9 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 78.5 | | |
| Intersection Capacity Utilization | 63.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1015 | 0 | 0 | 530 |
| Future Volume (vph) | 0 | 0 | 1015 | 0 | 0 | 530 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1103 | 0 | 0 | 576 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1103 | 0 | 0 | 576 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 56.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

Intersection Sign configuration not allowed in HCM analysis.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1655 | 5 | 590 | 5 | 5 | 5 | 1080 | 55 | 5 | 5 | 880 | 435 |
| Future Volume (vph) | 1655 | 5 | 590 | 5 | 5 | 5 | 1080 | 55 | 5 | 5 | 880 | 435 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.919 | | | 0.955 | | | 0.988 | | | | 0.850 |
| Flt Protected | 0.950 | 0.978 | | | 0.984 | | 0.950 | | | | | |
| Satd. Flow (prot) | 1633 | 1545 | 0 | 0 | 1700 | 0 | 1719 | 1788 | 0 | 0 | 3438 | 1538 |
| Flt Permitted | 0.644 | 0.786 | | | 0.702 | | 0.157 | | | | 0.954 | |
| Satd. Flow (perm) | 1107 | 1242 | 0 | 0 | 1213 | 0 | 284 | 1788 | 0 | 0 | 3280 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 85 | | | 5 | | | 5 | | | | 351 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1799 | 5 | 641 | 5 | 5 | 5 | 1174 | 60 | 5 | 5 | 957 | 473 |
| Shared Lane Traffic (%) | 30% | | | | | | | | | | | |
| Lane Group Flow (vph) | 1259 | 1186 | 0 | 0 | 15 | 0 | 1174 | 65 | 0 | 0 | 962 | 473 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

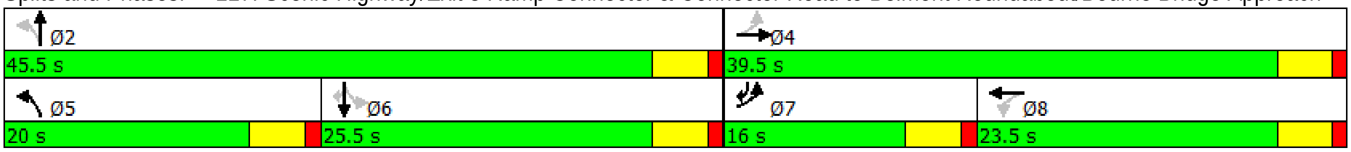
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 16.0 | 39.5 | | 23.5 | 23.5 | | 20.0 | 45.5 | | 25.5 | 25.5 | 16.0 |
| Total Split (%) | 18.8% | 46.5% | | 27.6% | 27.6% | | 23.5% | 53.5% | | 30.0% | 30.0% | 18.8% |
| Maximum Green (s) | 11.5 | 35.0 | | 19.0 | 19.0 | | 15.5 | 41.0 | | 21.0 | 21.0 | 11.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 35.0 | 35.0 | | | 8.7 | | 41.0 | 41.0 | | | 21.0 | 55.8 |
| Actuated g/C Ratio | 0.41 | 0.41 | | | 0.10 | | 0.48 | 0.48 | | | 0.25 | 0.66 |
| v/c Ratio | 1.96 | 1.77 | | | 0.12 | | 2.95 | 0.08 | | | 1.19 | 0.42 |
| Control Delay | 458.5 | 375.2 | | | 26.9 | | 900.0 | 11.4 | | | 127.7 | 4.1 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 458.5 | 375.2 | | | 26.9 | | 900.0 | 11.4 | | | 127.7 | 4.1 |
| LOS | F | F | | | C | | F | B | | | F | A |
| Approach Delay | | 418.1 | | | 26.9 | | | 853.4 | | | 87.0 | |
| Approach LOS | | F | | | C | | | F | | | F | |
| Queue Length 50th (ft) | ~1093 | ~982 | | | 5 | | ~1068 | 16 | | | ~330 | 17 |
| Queue Length 95th (ft) | #1435 | #1293 | | | 20 | | #1314 | 37 | | | #450 | 117 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 643 | 669 | | | 275 | | 398 | 865 | | | 810 | 1129 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.96 | 1.77 | | | 0.05 | | 2.95 | 0.08 | | | 1.19 | 0.42 |

Intersection Summary

Area Type: Other
Cycle Length: 85
Actuated Cycle Length: 85
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.95
Intersection Signal Delay: 429.5 Intersection LOS: F
Intersection Capacity Utilization 166.2% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1655 | 5 | 590 | 5 | 5 | 5 | 1080 | 55 | 5 | 5 | 880 | 435 |
| Future Volume (vph) | 1655 | 5 | 590 | 5 | 5 | 5 | 1080 | 55 | 5 | 5 | 880 | 435 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 1.00 | 1.00 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 0.99 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 1.00 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1545 | | | 1700 | | 1719 | 1789 | | | 3437 | 1538 |
| Flt Permitted | 0.64 | 0.79 | | | 0.70 | | 0.16 | 1.00 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1108 | 1241 | | | 1213 | | 284 | 1789 | | | 3280 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1799 | 5 | 641 | 5 | 5 | 5 | 1174 | 60 | 5 | 5 | 957 | 473 |
| RTOR Reduction (vph) | 0 | 48 | 0 | 0 | 5 | 0 | 0 | 3 | 0 | 0 | 0 | 148 |
| Lane Group Flow (vph) | 1259 | 1138 | 0 | 0 | 10 | 0 | 1174 | 62 | 0 | 0 | 962 | 325 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 38.6 | 38.6 | | | 3.8 | | 41.0 | 41.0 | | | 21.0 | 51.3 |
| Effective Green, g (s) | 38.6 | 38.6 | | | 3.8 | | 41.0 | 41.0 | | | 21.0 | 51.3 |
| Actuated g/C Ratio | 0.44 | 0.44 | | | 0.04 | | 0.46 | 0.46 | | | 0.24 | 0.58 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 662 | 644 | | | 52 | | 382 | 827 | | | 777 | 968 |
| v/s Ratio Prot | c0.65 | 0.60 | | | | | c0.54 | 0.03 | | | | 0.11 |
| v/s Ratio Perm | c0.18 | 0.17 | | | 0.01 | | c0.88 | | | | 0.29 | 0.10 |
| v/c Ratio | 1.90 | 1.77 | | | 0.20 | | 3.07 | 0.08 | | | 1.24 | 0.34 |
| Uniform Delay, d1 | 24.2 | 25.0 | | | 40.9 | | 24.3 | 13.2 | | | 33.8 | 9.7 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 411.5 | 351.5 | | | 1.9 | | 939.9 | 0.0 | | | 118.1 | 0.2 |
| Delay (s) | 435.7 | 376.5 | | | 42.8 | | 964.2 | 13.3 | | | 151.9 | 10.0 |
| Level of Service | F | F | | | D | | F | B | | | F | A |
| Approach Delay (s) | | 407.0 | | | 42.8 | | | 914.3 | | | 105.1 | |
| Approach LOS | | F | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 444.0 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 2.73 | | |
| Actuated Cycle Length (s) | 88.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 166.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 65 | 440 | 260 | 85 | 500 | 15 |
| Future Volume (vph) | 65 | 440 | 260 | 85 | 500 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.967 | | 0.996 | |
| Flt Protected | | 0.994 | | | 0.954 | |
| Satd. Flow (prot) | 0 | 1799 | 1750 | 0 | 1719 | 0 |
| Flt Permitted | | 0.994 | | | 0.954 | |
| Satd. Flow (perm) | 0 | 1799 | 1750 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 71 | 478 | 283 | 92 | 543 | 16 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 549 | 375 | 0 | 559 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 84.2% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 65 | 440 | 260 | 85 | 500 | 15 |
| Future Volume (Veh/h) | 65 | 440 | 260 | 85 | 500 | 15 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 71 | 478 | 283 | 92 | 543 | 16 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 375 | | | | 949 | 329 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 375 | | | | 949 | 329 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 94 | | | | 0 | 98 |
| cM capacity (veh/h) | 1167 | | | | 268 | 706 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 549 | 375 | 559 |
| Volume Left | 71 | 0 | 543 |
| Volume Right | 0 | 92 | 16 |
| cSH | 1167 | 1700 | 273 |
| Volume to Capacity | 0.06 | 0.22 | 2.05 |
| Queue Length 95th (ft) | 5 | 0 | 1022 |
| Control Delay (s) | 1.7 | 0.0 | 514.4 |
| Lane LOS | A | | F |
| Approach Delay (s) | 1.7 | 0.0 | 514.4 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 194.5 | | |
| Intersection Capacity Utilization | 84.2% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Future Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 83.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Intersection Sign configuration not allowed in HCM analysis.

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 510 | 260 | 50 | 700 |
| Future Volume (vph) | 0 | 0 | 510 | 260 | 50 | 700 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | |
| Flt Protected | | | | | | 0.997 |
| Satd. Flow (prot) | 0 | 0 | 1810 | 1538 | 0 | 1804 |
| Flt Permitted | | | | | | 0.997 |
| Satd. Flow (perm) | 0 | 0 | 1810 | 1538 | 0 | 1804 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 815 | | 173 | | | 967 |
| Travel Time (s) | 18.5 | | 3.9 | | | 22.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 554 | 283 | 54 | 761 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 554 | 283 | 0 | 815 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 73.1% | ICU Level of Service D |
| Analysis Period (min) 15 | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 0 | 510 | 260 | 50 | 700 |
| Future Volume (Veh/h) | 0 | 0 | 510 | 260 | 50 | 700 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 0 | 554 | 283 | 54 | 761 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1423 | 554 | | | 554 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1423 | 554 | | | 554 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 100 | 100 | | | 95 | |
| cM capacity (veh/h) | 140 | 526 | | | 1001 | |

| Direction, Lane # | NB 1 | NB 2 | SB 1 |
|---|---|---|---|
| Volume Total | 554 | 283 | 815 |
| Volume Left | 0 | 0 | 54 |
| Volume Right | 0 | 283 | 0 |
| cSH | 1700 | 1700 | 1001 |
| Volume to Capacity | 0.33 | 0.17 | 0.05 |
| Queue Length 95th (ft) | 0 | 0 | 4 |
| Control Delay (s) | 0.0 | 0.0 | 1.4 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | | 1.4 |
| Approach LOS | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 73.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 55 | 215 | 0 | 510 | 535 | 0 |
| Future Volume (vph) | 55 | 215 | 0 | 510 | 535 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.893 | | | | | |
| Flt Protected | 0.990 | | | | | |
| Satd. Flow (prot) | 1600 | 0 | 0 | 1810 | 1810 | 0 |
| Flt Permitted | 0.990 | | | | | |
| Satd. Flow (perm) | 1600 | 0 | 0 | 1810 | 1810 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 269 | | | 967 | 341 | |
| Travel Time (s) | 6.1 | | | 22.0 | 7.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 234 | 0 | 554 | 582 | 0 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 294 | 0 | 0 | 554 | 582 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Sign Control | Stop | | | Free | Free | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 51.1% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 55 | 215 | 0 | 510 | 535 | 0 |
| Future Volume (Veh/h) | 55 | 215 | 0 | 510 | 535 | 0 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 60 | 234 | 0 | 554 | 582 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1136 | 582 | 582 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1136 | 582 | 582 | | | |
| tC, single (s) | 6.4 | 6.2 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 73 | 54 | 100 | | | |
| cM capacity (veh/h) | 220 | 507 | 978 | | | |

| Direction, Lane # | EB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 294 | 554 | 582 |
| Volume Left | 60 | 0 | 0 |
| Volume Right | 234 | 0 | 0 |
| cSH | 401 | 1700 | 1700 |
| Volume to Capacity | 0.73 | 0.33 | 0.34 |
| Queue Length 95th (ft) | 144 | 0 | 0 |
| Control Delay (s) | 35.0 | 0.0 | 0.0 |
| Lane LOS | E | | |
| Approach Delay (s) | 35.0 | 0.0 | 0.0 |
| Approach LOS | E | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.2 | | |
| Intersection Capacity Utilization | 51.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Lane Group | NBL | NBT | SBT | SBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 1080 | 35 | 0 | 5 | 1730 |
| Future Volume (vph) | 0 | 1080 | 35 | 0 | 5 | 1730 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | 0.865 | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 1565 | 0 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 429 | 887 | | 645 | |
| Travel Time (s) | | 9.8 | 20.2 | | 14.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 1174 | 38 | 0 | 5 | 1880 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1174 | 38 | 0 | 1885 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 170.9% | ICU Level of Service H |
| Analysis Period (min) 15 | |

| Movement | NBL | NBT | SBT | SBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 1080 | 35 | 0 | 5 | 1730 |
| Future Volume (Veh/h) | 0 | 1080 | 35 | 0 | 5 | 1730 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 1174 | 38 | 0 | 5 | 1880 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 38 | | | | 1212 | 38 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 38 | | | | 1212 | 38 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 97 | 0 |
| cM capacity (veh/h) | 1553 | | | | 198 | 1025 |

| Direction, Lane # | NB 1 | SB 1 | SE 1 |
|---|---|---|---|
| Volume Total | 1174 | 38 | 1885 |
| Volume Left | 0 | 0 | 5 |
| Volume Right | 0 | 0 | 1880 |
| cSH | 1700 | 1700 | 1014 |
| Volume to Capacity | 0.69 | 0.02 | 1.86 |
| Queue Length 95th (ft) | 0 | 0 | 2875 |
| Control Delay (s) | 0.0 | 0.0 | 402.5 |
| Lane LOS | | | F |
| Approach Delay (s) | 0.0 | 0.0 | 402.5 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 245.0 | | |
| Intersection Capacity Utilization | 170.9% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 50 | 1035 | 25 | 35 |
| Future Volume (vph) | 0 | 0 | 50 | 1035 | 25 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | |
| Flt Protected | | | | | | 0.980 |
| Satd. Flow (prot) | 0 | 0 | 1810 | 1538 | 0 | 1773 |
| Flt Permitted | | | | | | 0.980 |
| Satd. Flow (perm) | 0 | 0 | 1810 | 1538 | 0 | 1773 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 263 | | 139 | | | 83 |
| Travel Time (s) | 6.0 | | 3.2 | | | 1.9 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 54 | 1125 | 27 | 38 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 54 | 1125 | 0 | 65 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 74.1% ICU Level of Service D

Analysis Period (min) 15

| Movement | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 0 | 50 | 1035 | 25 | 35 |
| Future Volume (Veh/h) | 0 | 0 | 50 | 1035 | 25 | 35 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 0 | 54 | 1125 | 27 | 38 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 146 | 54 | | | 54 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 146 | 54 | | | 54 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 100 | 100 | | | 98 | |
| cM capacity (veh/h) | 825 | 1005 | | | 1532 | |

| Direction, Lane # | NE 1 | NE 2 | SW 1 |
|---|---|---|---|
| Volume Total | 54 | 1125 | 65 |
| Volume Left | 0 | 0 | 27 |
| Volume Right | 0 | 1125 | 0 |
| cSH | 1700 | 1700 | 1532 |
| Volume to Capacity | 0.03 | 0.66 | 0.02 |
| Queue Length 95th (ft) | 0 | 0 | 1 |
| Control Delay (s) | 0.0 | 0.0 | 3.1 |
| Lane LOS | | | A |
| Approach Delay (s) | 0.0 | | 3.1 |
| Approach LOS | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.2 | | |
| Intersection Capacity Utilization | 74.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 1450 | 5 | 0 | 1030 | 5 | 5 |
| Future Volume (vph) | 1450 | 5 | 0 | 1030 | 5 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | 0.932 | |
| Flt Protected | | | | | 0.976 | |
| Satd. Flow (prot) | 1810 | 0 | 0 | 1810 | 1646 | 0 |
| Flt Permitted | | | | | 0.976 | |
| Satd. Flow (perm) | 1810 | 0 | 0 | 1810 | 1646 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 915 | | | 3519 | 548 | |
| Travel Time (s) | 20.8 | | | 80.0 | 12.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1576 | 5 | 0 | 1120 | 5 | 5 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 1581 | 0 | 0 | 1120 | 10 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 86.6% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 1450 | 5 | 0 | 1030 | 5 | 5 |
| Future Volume (Veh/h) | 1450 | 5 | 0 | 1030 | 5 | 5 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 1576 | 5 | 0 | 1120 | 5 | 5 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 1581 | | 2698 | 1578 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 1581 | | 2698 | 1578 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 100 | | 78 | 96 |
| cM capacity (veh/h) | | | 408 | | 23 | 132 |

| Direction, Lane # | NB 1 | SB 1 | NW 1 |
|---|---|---|---|
| Volume Total | 1581 | 1120 | 10 |
| Volume Left | 0 | 0 | 5 |
| Volume Right | 5 | 0 | 5 |
| cSH | 1700 | 408 | 39 |
| Volume to Capacity | 0.93 | 0.00 | 0.25 |
| Queue Length 95th (ft) | 0 | 0 | 21 |
| Control Delay (s) | 0.0 | 0.0 | 125.4 |
| Lane LOS | | | F |
| Approach Delay (s) | 0.0 | 0.0 | 125.4 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 86.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1450 | 5 | 5 | 1020 |
| Future Volume (vph) | 0 | 0 | 1450 | 5 | 5 | 1020 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 1810 | 0 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 1810 | 0 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 350 | | 636 | | | 590 |
| Travel Time (s) | 8.0 | | 14.5 | | | 13.4 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1576 | 5 | 5 | 1109 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1581 | 0 | 0 | 1114 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 80.0% ICU Level of Service D

Analysis Period (min) 15

| Movement | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 0 | 1450 | 5 | 5 | 1020 |
| Future Volume (Veh/h) | 0 | 0 | 1450 | 5 | 5 | 1020 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 0 | 1576 | 5 | 5 | 1109 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2698 | 1578 | | | 1581 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2698 | 1578 | | | 1581 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 100 | 100 | | | 99 | |
| cM capacity (veh/h) | 23 | 132 | | | 408 | |

| Direction, Lane # | WB 1 | NE 1 | SW 1 |
|---|---|---|---|
| Volume Total | 0 | 1581 | 1114 |
| Volume Left | 0 | 0 | 5 |
| Volume Right | 0 | 5 | 0 |
| cSH | 1700 | 1700 | 408 |
| Volume to Capacity | 0.00 | 0.93 | 0.01 |
| Queue Length 95th (ft) | 0 | 0 | 1 |
| Control Delay (s) | 0.0 | 0.0 | 0.6 |
| Lane LOS | A | | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.6 |
| Approach LOS | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.2 | | |
| Intersection Capacity Utilization | 80.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

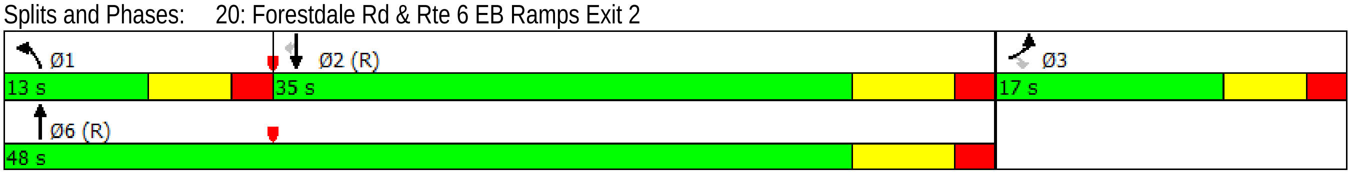
| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 55 | 625 | 60 | 1120 | 225 | 90 |
| Future Volume (vph) | 55 | 625 | 60 | 1120 | 225 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | 0.950 | | | |
| Satd. Flow (prot) | 1719 | 1538 | 1719 | 1810 | 1810 | 1538 |
| Flt Permitted | 0.950 | | 0.950 | | | |
| Satd. Flow (perm) | 1719 | 1538 | 1719 | 1810 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 639 | | | | 98 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 181 | | | 443 | 226 | |
| Travel Time (s) | 4.1 | | | 10.1 | 5.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 679 | 65 | 1217 | 245 | 98 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 60 | 679 | 65 | 1217 | 245 | 98 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | 1 | 1 | 2 | 2 | 1 |
| Detector Template | Left | Right | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | 20 | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 20 | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 3 | | 1 | 6 | 2 | |
| Permitted Phases | | 3 | | | | 2 |
| Detector Phase | 3 | 3 | 1 | 6 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 11.0 | 11.0 | 11.0 | 17.0 | 17.0 | 17.0 |
| Total Split (s) | 17.0 | 17.0 | 13.0 | 48.0 | 35.0 | 35.0 |
| Total Split (%) | 26.2% | 26.2% | 20.0% | 73.8% | 53.8% | 53.8% |
| Maximum Green (s) | 11.0 | 11.0 | 7.0 | 41.0 | 28.0 | 28.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 5.0 | 5.0 | 5.0 |
| All-Red Time (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 6.0 | 6.0 | 6.0 | 7.0 | 7.0 | 7.0 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Recall Mode | None | None | None | C-Min | C-Min | C-Min |
| Act Effct Green (s) | 9.3 | 9.3 | 6.3 | 42.7 | 34.9 | 34.9 |
| Actuated g/C Ratio | 0.14 | 0.14 | 0.10 | 0.66 | 0.54 | 0.54 |
| v/c Ratio | 0.24 | 0.89 | 0.39 | 1.02 | 0.25 | 0.11 |
| Control Delay | 26.5 | 19.2 | 34.5 | 47.7 | 3.0 | 0.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 26.5 | 19.2 | 34.5 | 47.7 | 3.0 | 0.5 |
| LOS | C | B | C | D | A | A |
| Approach Delay | 19.8 | | | 47.0 | 2.3 | |
| Approach LOS | B | | | D | A | |
| 90th %ile Green (s) | 11.0 | 11.0 | 7.0 | 41.0 | 28.0 | 28.0 |
| 90th %ile Term Code | Max | Max | Max | Coord | Coord | Coord |
| 70th %ile Green (s) | 11.0 | 11.0 | 7.0 | 41.0 | 28.0 | 28.0 |
| 70th %ile Term Code | Max | Max | Max | Coord | Coord | Coord |
| 50th %ile Green (s) | 10.3 | 10.3 | 6.8 | 41.7 | 28.9 | 28.9 |
| 50th %ile Term Code | Gap | Gap | Gap | Coord | Coord | Coord |
| 30th %ile Green (s) | 7.3 | 7.3 | 0.0 | 44.7 | 44.7 | 44.7 |
| 30th %ile Term Code | Gap | Gap | Skip | Coord | Coord | Coord |
| 10th %ile Green (s) | 6.9 | 6.9 | 0.0 | 45.1 | 45.1 | 45.1 |
| 10th %ile Term Code | Gap | Gap | Skip | Coord | Coord | Coord |
| Stops (vph) | 49 | 81 | 55 | 798 | 23 | 1 |
| Fuel Used(gal) | 1 | 5 | 5 | 88 | 1 | 0 |
| CO Emissions (g/hr) | 53 | 351 | 325 | 6180 | 103 | 35 |
| NOx Emissions (g/hr) | 10 | 68 | 63 | 1202 | 20 | 7 |
| VOC Emissions (g/hr) | 12 | 81 | 75 | 1432 | 24 | 8 |
| Dilemma Vehicles (#) | 0 | 0 | 0 | 0 | 0 | 0 |
| Queue Length 50th (ft) | 21 | 14 | 25 | ~540 | 10 | 0 |
| Queue Length 95th (ft) | 51 | #189 | 58 | #771 | 26 | 0 |
| Internal Link Dist (ft) | 101 | | | 363 | 146 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 290 | 791 | 185 | 1188 | 972 | 872 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.21 | 0.86 | 0.35 | 1.02 | 0.25 | 0.11 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 65 | |

Actuated Cycle Length: 65
Offset: 0 (0%), Referenced to phase 2:SBT and 6:NBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 32.0 Intersection LOS: C
Intersection Capacity Utilization 73.9% ICU Level of Service D
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 20: Forestdale Rd & Rte 6 EB Ramps Exit 2



| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 55 | 625 | 60 | 1120 | 225 | 90 |
| Future Volume (vph) | 55 | 625 | 60 | 1120 | 225 | 90 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 6.0 | 6.0 | 6.0 | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1538 | 1719 | 1810 | 1810 | 1538 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1719 | 1538 | 1719 | 1810 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 60 | 679 | 65 | 1217 | 245 | 98 |
| RTOR Reduction (vph) | 0 | 548 | 0 | 0 | 0 | 49 |
| Lane Group Flow (vph) | 60 | 131 | 65 | 1217 | 245 | 49 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 3 | | 1 | 6 | 2 | |
| Permitted Phases | | 3 | | | | 2 |
| Actuated Green, G (s) | 9.3 | 9.3 | 4.2 | 42.7 | 32.5 | 32.5 |
| Effective Green, g (s) | 9.3 | 9.3 | 4.2 | 42.7 | 32.5 | 32.5 |
| Actuated g/C Ratio | 0.14 | 0.14 | 0.06 | 0.66 | 0.50 | 0.50 |
| Clearance Time (s) | 6.0 | 6.0 | 6.0 | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lane Grp Cap (vph) | 245 | 220 | 111 | 1189 | 905 | 769 |
| v/s Ratio Prot | 0.03 | | 0.04 | c0.67 | 0.14 | |
| v/s Ratio Perm | | c0.09 | | | | 0.03 |
| v/c Ratio | 0.24 | 0.60 | 0.59 | 1.02 | 0.27 | 0.06 |
| Uniform Delay, d1 | 24.7 | 26.1 | 29.6 | 11.1 | 9.4 | 8.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.23 | 0.07 |
| Incremental Delay, d2 | 0.2 | 2.9 | 5.0 | 32.2 | 0.7 | 0.2 |
| Delay (s) | 24.9 | 29.0 | 34.6 | 43.4 | 2.9 | 0.8 |
| Level of Service | C | C | C | D | A | A |
| Approach Delay (s) | 28.7 | | | 42.9 | 2.3 | |
| Approach LOS | C | | | D | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 32.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 65.0 | Sum of lost time (s) | 19.0 |
| Intersection Capacity Utilization | 73.9% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

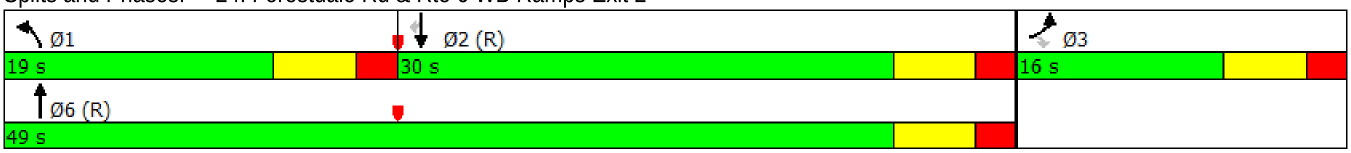
c Critical Lane Group

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 205 | 60 | 530 | 645 | 255 | 30 |
| Future Volume (vph) | 205 | 60 | 530 | 645 | 255 | 30 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | 0 | 300 | | | 0 |
| Storage Lanes | 1 | 1 | 2 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | 0.950 | | | |
| Satd. Flow (prot) | 1719 | 1538 | 3335 | 1810 | 1810 | 1538 |
| Flt Permitted | 0.950 | | 0.950 | | | |
| Satd. Flow (perm) | 1719 | 1538 | 3335 | 1810 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 65 | | | | 33 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 441 | | | 372 | 296 | |
| Travel Time (s) | 10.0 | | | 8.5 | 6.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 223 | 65 | 576 | 701 | 277 | 33 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 223 | 65 | 576 | 701 | 277 | 33 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 24 | 24 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | 1 | 1 | 2 | 2 | 1 |
| Detector Template | Left | Right | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | 20 | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 20 | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 3 | | 1 | 6 | 2 | |
| Permitted Phases | | 3 | | | | 2 |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 3 | 3 | 1 | 6 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 |
| Minimum Split (s) | 11.0 | 11.0 | 11.0 | 16.0 | 16.0 | 16.0 |
| Total Split (s) | 16.0 | 16.0 | 19.0 | 49.0 | 30.0 | 30.0 |
| Total Split (%) | 24.6% | 24.6% | 29.2% | 75.4% | 46.2% | 46.2% |
| Maximum Green (s) | 10.0 | 10.0 | 13.0 | 43.0 | 24.0 | 24.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Recall Mode | None | None | None | C-Min | C-Min | C-Min |
| Act Effct Green (s) | 12.7 | 12.7 | 14.0 | 40.3 | 20.3 | 20.3 |
| Actuated g/C Ratio | 0.20 | 0.20 | 0.22 | 0.62 | 0.31 | 0.31 |
| v/c Ratio | 0.67 | 0.19 | 0.80 | 0.62 | 0.49 | 0.07 |
| Control Delay | 35.0 | 8.0 | 20.8 | 16.5 | 22.5 | 6.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 35.0 | 8.0 | 20.8 | 16.5 | 22.5 | 6.9 |
| LOS | C | A | C | B | C | A |
| Approach Delay | 28.9 | | | 18.4 | 20.8 | |
| Approach LOS | C | | | B | C | |
| 90th %ile Green (s) | 12.9 | 12.9 | 13.0 | 40.1 | 21.1 | 21.1 |
| 90th %ile Term Code | Max | Max | Max | Coord | Coord | Coord |
| 70th %ile Green (s) | 15.5 | 15.5 | 14.7 | 37.5 | 16.8 | 16.8 |
| 70th %ile Term Code | Gap | Gap | Max | Coord | Coord | Coord |
| 50th %ile Green (s) | 14.0 | 14.0 | 16.1 | 39.0 | 16.9 | 16.9 |
| 50th %ile Term Code | Gap | Gap | Gap | Coord | Coord | Coord |
| 30th %ile Green (s) | 12.0 | 12.0 | 14.4 | 41.0 | 20.6 | 20.6 |
| 30th %ile Term Code | Gap | Gap | Gap | Coord | Coord | Coord |
| 10th %ile Green (s) | 8.9 | 8.9 | 11.9 | 44.1 | 26.2 | 26.2 |
| 10th %ile Term Code | Gap | Gap | Gap | Coord | Coord | Coord |
| Stops (vph) | 178 | 16 | 448 | 573 | 204 | 9 |
| Fuel Used(gal) | 3 | 0 | 8 | 9 | 12 | 1 |
| CO Emissions (g/hr) | 220 | 27 | 530 | 615 | 824 | 85 |
| NOx Emissions (g/hr) | 43 | 5 | 103 | 120 | 160 | 16 |
| VOC Emissions (g/hr) | 51 | 6 | 123 | 143 | 191 | 20 |
| Dilemma Vehicles (#) | 0 | 0 | 0 | 0 | 0 | 0 |
| Queue Length 50th (ft) | 80 | 0 | 89 | 302 | 96 | 0 |
| Queue Length 95th (ft) | #165 | 28 | m110 | m260 | 150 | 16 |
| Internal Link Dist (ft) | 361 | | | 292 | 216 | |
| Turn Bay Length (ft) | | | 300 | | | |
| Base Capacity (vph) | 340 | 356 | 730 | 1203 | 680 | 598 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.66 | 0.18 | 0.79 | 0.58 | 0.41 | 0.06 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 65 | |
| Actuated Cycle Length: 65 | |
| Offset: 52 (80%), Referenced to phase 2:SBT and 6:NBT, Start of Green | |
| Natural Cycle: 55 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.80 | |
| Intersection Signal Delay: 20.4 | Intersection LOS: C |
| Intersection Capacity Utilization 55.3% | ICU Level of Service B |
| Analysis Period (min) 15 | |
| # 95th percentile volume exceeds capacity, queue may be longer. | |
| Queue shown is maximum after two cycles. | |
| m Volume for 95th percentile queue is metered by upstream signal. | |

Splits and Phases: 24: Forestdale Rd & Rte 6 WB Ramps Exit 2



| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 205 | 60 | 530 | 645 | 255 | 30 |
| Future Volume (vph) | 205 | 60 | 530 | 645 | 255 | 30 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1538 | 3335 | 1810 | 1810 | 1538 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1719 | 1538 | 3335 | 1810 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 223 | 65 | 576 | 701 | 277 | 33 |
| RTOR Reduction (vph) | 0 | 52 | 0 | 0 | 0 | 23 |
| Lane Group Flow (vph) | 223 | 13 | 576 | 701 | 277 | 10 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 3 | | 1 | 6 | 2 | |
| Permitted Phases | | 3 | | | | 2 |
| Actuated Green, G (s) | 12.7 | 12.7 | 14.0 | 40.3 | 20.3 | 20.3 |
| Effective Green, g (s) | 12.7 | 12.7 | 14.0 | 40.3 | 20.3 | 20.3 |
| Actuated g/C Ratio | 0.20 | 0.20 | 0.22 | 0.62 | 0.31 | 0.31 |
| Clearance Time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lane Grp Cap (vph) | 335 | 300 | 718 | 1122 | 565 | 480 |
| v/s Ratio Prot | c0.13 | | c0.17 | c0.39 | 0.15 | |
| v/s Ratio Perm | | 0.01 | | | | 0.01 |
| v/c Ratio | 0.67 | 0.04 | 0.80 | 0.62 | 0.49 | 0.02 |
| Uniform Delay, d1 | 24.2 | 21.2 | 24.2 | 7.7 | 18.1 | 15.5 |
| Progression Factor | 1.00 | 1.00 | 0.68 | 1.85 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.8 | 0.0 | 1.6 | 0.7 | 3.0 | 0.1 |
| Delay (s) | 28.0 | 21.2 | 18.0 | 14.9 | 21.2 | 15.6 |
| Level of Service | C | C | B | B | C | B |
| Approach Delay (s) | 26.5 | | | 16.3 | 20.6 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 18.5 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.72 | | |
| Actuated Cycle Length (s) | 65.0 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 55.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 545 | 10 | 435 | 345 | 10 | 525 |
| Future Volume (vph) | 545 | 10 | 435 | 345 | 10 | 525 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.998 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1806 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1806 | 0 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1449 | | | 900 | 376 | |
| Travel Time (s) | 32.9 | | | 20.5 | 8.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 592 | 11 | 473 | 375 | 11 | 571 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 603 | 0 | 473 | 375 | 11 | 571 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 68.5% ICU Level of Service C
Analysis Period (min) 15

| Movement | NBT | NBR | SBL | SBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 545 | 10 | 435 | 345 | 10 | 525 |
| Future Volume (Veh/h) | 545 | 10 | 435 | 345 | 10 | 525 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 592 | 11 | 473 | 375 | 11 | 571 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 603 | | 1918 | 598 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 603 | | 1918 | 598 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 51 | | 70 | 0 |
| cM capacity (veh/h) | | | 960 | | 37 | 497 |

| Direction, Lane # | NB 1 | SB 1 | SB 2 | NW 1 | NW 2 |
|---|---|---|---|---|---|
| Volume Total | 603 | 473 | 375 | 11 | 571 |
| Volume Left | 0 | 473 | 0 | 11 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 571 |
| cSH | 1700 | 960 | 1700 | 37 | 497 |
| Volume to Capacity | 0.35 | 0.49 | 0.22 | 0.30 | 1.15 |
| Queue Length 95th (ft) | 0 | 70 | 0 | 24 | 499 |
| Control Delay (s) | 0.0 | 12.3 | 0.0 | 139.8 | 115.5 |
| Lane LOS | | B | | F | F |
| Approach Delay (s) | 0.0 | 6.9 | | 115.9 | |
| Approach LOS | | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 36.1 | | |
| Intersection Capacity Utilization | 68.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Lane Group | NBT | NBR | SBL | SBT | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 760 | 95 | 20 | 485 | 85 | 10 |
| Future Volume (vph) | 760 | 95 | 20 | 485 | 85 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.985 | | | | 0.986 | |
| Flt Protected | | | | 0.998 | 0.957 | |
| Satd. Flow (prot) | 1782 | 0 | 0 | 1806 | 1707 | 0 |
| Flt Permitted | | | | 0.998 | 0.957 | |
| Satd. Flow (perm) | 1782 | 0 | 0 | 1806 | 1707 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 2701 | | | 935 | 1588 | |
| Travel Time (s) | 61.4 | | | 21.3 | 36.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 826 | 103 | 22 | 527 | 92 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 929 | 0 | 0 | 549 | 103 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 57.7% | ICU Level of Service B |
| Analysis Period (min) 15 | |

HCM Unsignalized Intersection Capacity Analysis
39: Forestdale Rd & Beale Ave 02/16/2018

| Movement | NBT | NBR | SBL | SBT | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 760 | 95 | 20 | 485 | 85 | 10 |
| Future Volume (Veh/h) | 760 | 95 | 20 | 485 | 85 | 10 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 826 | 103 | 22 | 527 | 92 | 11 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 929 | | 1448 | 878 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 929 | | 1448 | 878 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 97 | | 33 | 97 |
| cM capacity (veh/h) | | | 724 | | 138 | 343 |

| Direction, Lane # | NB 1 | SB 1 | SW 1 |
|---|---|---|---|
| Volume Total | 929 | 549 | 103 |
| Volume Left | 0 | 22 | 92 |
| Volume Right | 103 | 0 | 11 |
| cSH | 1700 | 724 | 147 |
| Volume to Capacity | 0.55 | 0.03 | 0.70 |
| Queue Length 95th (ft) | 0 | 2 | 101 |
| Control Delay (s) | 0.0 | 0.8 | 72.5 |
| Lane LOS | | A | F |
| Approach Delay (s) | 0.0 | 0.8 | 72.5 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.0 | | |
| Intersection Capacity Utilization | 57.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

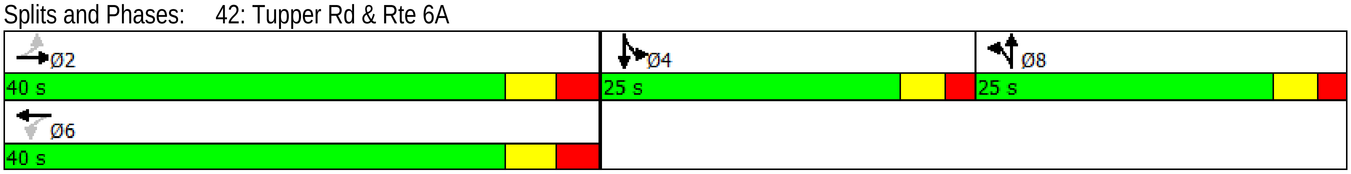
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 20 | 355 | 115 | 75 | 630 | 470 | 105 | 240 | 75 | 250 | 175 | 20 |
| Future Volume (vph) | 20 | 355 | 115 | 75 | 630 | 470 | 105 | 240 | 75 | 250 | 175 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 |
| Frt | | 0.965 | | | 0.940 | | | 0.976 | | | 0.993 | |
| Flt Protected | | 0.998 | | | 0.997 | | | 0.988 | | | 0.973 | |
| Satd. Flow (prot) | 0 | 3311 | 0 | 0 | 3222 | 0 | 0 | 1745 | 0 | 0 | 3322 | 0 |
| Flt Permitted | | 0.722 | | | 0.831 | | | 0.988 | | | 0.973 | |
| Satd. Flow (perm) | 0 | 2395 | 0 | 0 | 2686 | 0 | 0 | 1745 | 0 | 0 | 3322 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 51 | | | 201 | | | 11 | | | 5 | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 199 | | | 602 | | | 623 | | | 129 | |
| Travel Time (s) | | 4.5 | | | 13.7 | | | 14.2 | | | 2.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 386 | 125 | 82 | 685 | 511 | 114 | 261 | 82 | 272 | 190 | 22 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 533 | 0 | 0 | 1278 | 0 | 0 | 457 | 0 | 0 | 484 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | Split | NA | |
| Protected Phases | | 2 | | | 6 | | 8 | 8 | | 4 | 4 | |
| Permitted Phases | 2 | | | 6 | | | | | | | | |
| Detector Phase | 2 | 2 | | 6 | 6 | | 8 | 8 | | 4 | 4 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 14.0 | 14.0 | | 14.0 | 14.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 20.5 | 20.5 | | 20.5 | 20.5 | | 15.0 | 15.0 | | 15.0 | 15.0 | |
| Total Split (s) | 40.0 | 40.0 | | 40.0 | 40.0 | | 25.0 | 25.0 | | 25.0 | 25.0 | |
| Total Split (%) | 44.4% | 44.4% | | 44.4% | 44.4% | | 27.8% | 27.8% | | 27.8% | 27.8% | |
| Maximum Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 20.0 | 20.0 | |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| All-Red Time (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 2.0 | 2.0 | | 2.0 | 2.0 | |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Total Lost Time (s) | | 6.5 | | | 6.5 | | | 5.0 | | | 5.0 | |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Recall Mode | Min | Min | | Min | Min | | None | None | | None | None | |
| Act Effct Green (s) | | 33.5 | | | 33.5 | | | 20.0 | | | 17.3 | |
| Actuated g/C Ratio | | 0.38 | | | 0.38 | | | 0.23 | | | 0.20 | |
| v/c Ratio | | 0.56 | | | 1.11 | | | 1.12 | | | 0.73 | |
| Control Delay | | 22.2 | | | 85.3 | | | 114.9 | | | 39.5 | |
| Queue Delay | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Total Delay | | 22.2 | | | 85.3 | | | 114.9 | | | 39.5 | |
| LOS | | C | | | F | | | F | | | D | |
| Approach Delay | | 22.2 | | | 85.3 | | | 114.9 | | | 39.5 | |
| Approach LOS | | C | | | F | | | F | | | D | |
| 90th %ile Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 20.0 | 20.0 | |
| 90th %ile Term Code | Hold | Hold | | Max | Max | | Max | Max | | Max | Max | |
| 70th %ile Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 20.0 | 20.0 | |
| 70th %ile Term Code | Hold | Hold | | Max | Max | | Max | Max | | Max | Max | |
| 50th %ile Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 18.7 | 18.7 | |
| 50th %ile Term Code | Hold | Hold | | Max | Max | | Max | Max | | Gap | Gap | |
| 30th %ile Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 15.6 | 15.6 | |
| 30th %ile Term Code | Hold | Hold | | Max | Max | | Max | Max | | Gap | Gap | |
| 10th %ile Green (s) | 33.5 | 33.5 | | 33.5 | 33.5 | | 20.0 | 20.0 | | 12.7 | 12.7 | |
| 10th %ile Term Code | Hold | Hold | | Max | Max | | Max | Max | | Gap | Gap | |
| Stops (vph) | | 340 | | | 856 | | | 329 | | | 397 | |
| Fuel Used(gal) | | 7 | | | 31 | | | 14 | | | 8 | |
| CO Emissions (g/hr) | | 493 | | | 2144 | | | 957 | | | 544 | |
| NOx Emissions (g/hr) | | 96 | | | 417 | | | 186 | | | 106 | |
| VOC Emissions (g/hr) | | 114 | | | 497 | | | 222 | | | 126 | |
| Dilemma Vehicles (#) | | 0 | | | 0 | | | 0 | | | 0 | |
| Queue Length 50th (ft) | | 110 | | | ~400 | | | ~298 | | | 131 | |
| Queue Length 95th (ft) | | 166 | | | #543 | | | #494 | | | 184 | |
| Internal Link Dist (ft) | | 119 | | | 522 | | | 543 | | | 49 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | 950 | | | 1154 | | | 408 | | | 765 | |
| Starvation Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | |
| Spillback Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | |
| Storage Cap Reductn | | 0 | | | 0 | | | 0 | | | 0 | |
| Reduced v/c Ratio | | 0.56 | | | 1.11 | | | 1.12 | | | 0.63 | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 90 | |

Actuated Cycle Length: 87.4
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.12
Intersection Signal Delay: 69.9 Intersection LOS: E
Intersection Capacity Utilization 104.8% ICU Level of Service G
Analysis Period (min) 15
90th %ile Actuated Cycle: 90
70th %ile Actuated Cycle: 90
50th %ile Actuated Cycle: 88.7
30th %ile Actuated Cycle: 85.6
10th %ile Actuated Cycle: 82.7
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 42: Tupper Rd & Rte 6A



HCM Signalized Intersection Capacity Analysis
42: Tupper Rd & Rte 6A 02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 20 | 355 | 115 | 75 | 630 | 470 | 105 | 240 | 75 | 250 | 175 | 20 |
| Future Volume (vph) | 20 | 355 | 115 | 75 | 630 | 470 | 105 | 240 | 75 | 250 | 175 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 6.5 | | | 6.5 | | | 5.0 | | | 5.0 | |
| Lane Util. Factor | | 0.95 | | | 0.95 | | | 1.00 | | | 0.95 | |
| Frt | | 0.96 | | | 0.94 | | | 0.98 | | | 0.99 | |
| Flt Protected | | 1.00 | | | 1.00 | | | 0.99 | | | 0.97 | |
| Satd. Flow (prot) | | 3310 | | | 3222 | | | 1744 | | | 3321 | |
| Flt Permitted | | 0.72 | | | 0.83 | | | 0.99 | | | 0.97 | |
| Satd. Flow (perm) | | 2396 | | | 2685 | | | 1744 | | | 3321 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 386 | 125 | 82 | 685 | 511 | 114 | 261 | 82 | 272 | 190 | 22 |
| RTOR Reduction (vph) | 0 | 31 | 0 | 0 | 124 | 0 | 0 | 8 | 0 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 502 | 0 | 0 | 1154 | 0 | 0 | 449 | 0 | 0 | 480 | 0 |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | Split | NA | |
| Protected Phases | | 2 | | | 6 | | 8 | 8 | | 4 | 4 | |
| Permitted Phases | 2 | | | 6 | | | | | | | | |
| Actuated Green, G (s) | | 33.5 | | | 33.5 | | | 20.0 | | | 17.3 | |
| Effective Green, g (s) | | 33.5 | | | 33.5 | | | 20.0 | | | 17.3 | |
| Actuated g/C Ratio | | 0.38 | | | 0.38 | | | 0.23 | | | 0.20 | |
| Clearance Time (s) | | 6.5 | | | 6.5 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | | 919 | | | 1030 | | | 399 | | | 658 | |
| v/s Ratio Prot | | | | | | | | c0.26 | | | c0.14 | |
| v/s Ratio Perm | | 0.21 | | | c0.43 | | | | | | | |
| v/c Ratio | | 0.55 | | | 1.12 | | | 1.12 | | | 0.73 | |
| Uniform Delay, d1 | | 21.0 | | | 26.9 | | | 33.6 | | | 32.8 | |
| Progression Factor | | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | | 0.7 | | | 67.3 | | | 83.3 | | | 4.1 | |
| Delay (s) | | 21.6 | | | 94.2 | | | 116.9 | | | 36.9 | |
| Level of Service | | C | | | F | | | F | | | D | |
| Approach Delay (s) | | 21.6 | | | 94.2 | | | 116.9 | | | 36.9 | |
| Approach LOS | | C | | | F | | | F | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 73.8 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 1.03 | | |
| Actuated Cycle Length (s) | 87.3 | Sum of lost time (s) | 16.5 |
| Intersection Capacity Utilization | 104.8% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 5 | 785 | 5 | 245 | 1005 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (vph) | 5 | 785 | 5 | 245 | 1005 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.999 | | | | | | | 0.850 | | 0.865 | |
| Flt Protected | | | | | 0.990 | | | 0.958 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 0 | 0 | 1791 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Flt Permitted | | | | | 0.990 | | | 0.958 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 0 | 0 | 1791 | 0 | 0 | 1734 | 1538 | 0 | 1565 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 724 | | | 1081 | | | 130 | | | 454 | |
| Travel Time (s) | | 16.5 | | | 24.6 | | | 3.0 | | | 10.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 5 | 853 | 5 | 266 | 1092 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 863 | 0 | 0 | 1363 | 0 | 0 | 38 | 71 | 0 | 5 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 127.2% | ICU Level of Service H |
| Analysis Period (min) 15 | |

# HCM Unsignalized Intersection Capacity Analysis
## 54: Cranberry Hwy/Regency Dr & Sandwich Rd/Rte 6A

02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ↰ | ↱ | | ✣ | |
| Traffic Volume (veh/h) | 5 | 785 | 5 | 245 | 1005 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Future Volume (Veh/h) | 5 | 785 | 5 | 245 | 1005 | 5 | 30 | 5 | 65 | 0 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 5 | 853 | 5 | 266 | 1092 | 5 | 33 | 5 | 71 | 0 | 0 | 5 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1097 | | | 858 | | | 2497 | 2494 | 856 | 2494 | 2494 | 1094 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1097 | | | 858 | | | 2497 | 2494 | 856 | 2494 | 2494 | 1094 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 65 | | | 0 | 73 | 80 | 100 | 100 | 98 |
| cM capacity (veh/h) | 625 | | | 770 | | | 14 | 18 | 353 | 9 | 18 | 256 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 | NE 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 863 | 1363 | 38 | 71 | 5 |
| Volume Left | 5 | 266 | 33 | 0 | 0 |
| Volume Right | 5 | 5 | 0 | 71 | 5 |
| cSH | 625 | 770 | 14 | 353 | 256 |
| Volume to Capacity | 0.01 | 0.35 | 2.69 | 0.20 | 0.02 |
| Queue Length 95th (ft) | 1 | 39 | 139 | 18 | 1 |
| Control Delay (s) | 0.2 | 11.9 | 1310.2 | 17.7 | 19.3 |
| Lane LOS | A | B | F | C | C |
| Approach Delay (s) | 0.2 | 11.9 | 468.3 | | 19.3 |
| Approach LOS | | | F | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 28.9 | | |
| Intersection Capacity Utilization | 127.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBR | EBR2 | NWL2 | NWL | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 0.95 |
| Frt | | | | | | | | | | | | |
| Flt Protected | | | | | | | | | | | | |
| Satd. Flow (prot) | 1810 | 0 | 1810 | 1810 | 0 | 1810 | 1810 | 3438 | 1810 | 1810 | 3438 | 0 |
| Flt Permitted | | | | | | | | | | | | |
| Satd. Flow (perm) | 1810 | 0 | 1810 | 1810 | 0 | 1810 | 1810 | 3438 | 1810 | 1810 | 3438 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | | | | | | | | | | |
| Link Speed (mph) | 30 | | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | 633 | | | | 167 | | | 285 | | | 418 | |
| Travel Time (s) | 14.4 | | | | 3.8 | | | 6.5 | | | 9.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | 12 | | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | 0 | | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | 16 | | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 9 | 15 | 15 | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | | 1 | 1 | | 1 | 1 | 2 | 1 | 1 | 2 | |
| Detector Template | Left | | Right | Left | | Right | Left | Thru | Right | Left | Thru | |
| Leading Detector (ft) | 20 | | 20 | 20 | | 20 | 20 | 100 | 20 | 20 | 100 | |
| Trailing Detector (ft) | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | | 20 | 20 | | 20 | 20 | 6 | 20 | 20 | 6 | |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | | | | | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | | | | | | | 6 | | | 6 | |
| Detector 2 Type | | | | | | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | | | | | | | 0.0 | | | 0.0 | |
| Turn Type | Prot | | Perm | Perm | | Perm | Perm | | Perm | Perm | | |
| Protected Phases | 4 | | | | | | | 2 | | | 6 | |
| Permitted Phases | | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Detector Phase | 4 | | 4 | 8 | | 8 | 2 | 2 | 2 | 6 | 6 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | | 10.0 | 10.0 | | 10.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | |

| Lane Group | Ø3 |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | |
| Future Volume (vph) | |
| Ideal Flow (vphpl) | |
| Lane Util. Factor | |
| Frt | |
| Flt Protected | |
| Satd. Flow (prot) | |
| Flt Permitted | |
| Satd. Flow (perm) | |
| Right Turn on Red | |
| Satd. Flow (RTOR) | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Peak Hour Factor | |
| Adj. Flow (vph) | |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | |
| Enter Blocked Intersection | |
| Lane Alignment | |
| Median Width(ft) | |
| Link Offset(ft) | |
| Crosswalk Width(ft) | |
| Two way Left Turn Lane | |
| Headway Factor | |
| Turning Speed (mph) | |
| Number of Detectors | |
| Detector Template | |
| Leading Detector (ft) | |
| Trailing Detector (ft) | |
| Detector 1 Position(ft) | |
| Detector 1 Size(ft) | |
| Detector 1 Type | |
| Detector 1 Channel | |
| Detector 1 Extend (s) | |
| Detector 1 Queue (s) | |
| Detector 1 Delay (s) | |
| Detector 2 Position(ft) | |
| Detector 2 Size(ft) | |
| Detector 2 Type | |
| Detector 2 Channel | |
| Detector 2 Extend (s) | |
| Turn Type | |
| Protected Phases | 3 |
| Permitted Phases | |
| Detector Phase | |
| Switch Phase | |
| Minimum Initial (s) | 7.0 |

| Lane Group | EBL | EBR | EBR2 | NWL2 | NWL | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 21.0 | | 21.0 | 21.0 | | 21.0 | 48.5 | 48.5 | 48.5 | 48.5 | 48.5 | |
| Total Split (s) | 21.0 | | 21.0 | 21.0 | | 21.0 | 58.5 | 58.5 | 58.5 | 58.0 | 58.0 | |
| Total Split (%) | 22.2% | | 22.2% | 22.2% | | 22.2% | 61.9% | 61.9% | 61.9% | 61.4% | 61.4% | |
| Maximum Green (s) | 16.0 | | 16.0 | 16.0 | | 16.0 | 50.0 | 50.0 | 50.0 | 49.5 | 49.5 | |
| Yellow Time (s) | 4.0 | | 4.0 | 4.0 | | 4.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | |
| Lead/Lag | Lag | | Lag | | | | | | | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | | | | | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | | None | None | | None | Max | Max | Max | Max | Max | |
| Walk Time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | | 11.0 | 11.0 | | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Act Effct Green (s) | | | | | | | | | | | | |
| Actuated g/C Ratio | | | | | | | | | | | | |
| v/c Ratio | | | | | | | | | | | | |
| Control Delay | | | | | | | | | | | | |
| Queue Delay | | | | | | | | | | | | |
| Total Delay | | | | | | | | | | | | |
| LOS | | | | | | | | | | | | |
| Approach Delay | | | | | | | | | | | | |
| Approach LOS | | | | | | | | | | | | |
| 90th %ile Green (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | |
| 90th %ile Term Code | Skip | | Skip | Skip | | Skip | Dwell | Dwell | Dwell | Dwell | Dwell | |
| 70th %ile Green (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | |
| 70th %ile Term Code | Skip | | Skip | Skip | | Skip | Dwell | Dwell | Dwell | Dwell | Dwell | |
| 50th %ile Green (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | |
| 50th %ile Term Code | Skip | | Skip | Skip | | Skip | Dwell | Dwell | Dwell | Dwell | Dwell | |
| 30th %ile Green (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | |
| 30th %ile Term Code | Skip | | Skip | Skip | | Skip | Dwell | Dwell | Dwell | Dwell | Dwell | |
| 10th %ile Green (s) | 0.0 | | 0.0 | 0.0 | | 0.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | |
| 10th %ile Term Code | Skip | | Skip | Skip | | Skip | Dwell | Dwell | Dwell | Dwell | Dwell | |
| Stops (vph) | | | | | | | | | | | | |
| Fuel Used(gal) | | | | | | | | | | | | |
| CO Emissions (g/hr) | | | | | | | | | | | | |
| NOx Emissions (g/hr) | | | | | | | | | | | | |
| VOC Emissions (g/hr) | | | | | | | | | | | | |
| Dilemma Vehicles (#) | | | | | | | | | | | | |
| Queue Length 50th (ft) | | | | | | | | | | | | |
| Queue Length 95th (ft) | | | | | | | | | | | | |
| Internal Link Dist (ft) | 553 | | | | 87 | | | 205 | | | 338 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | | | | | | | | | | | | |
| Starvation Cap Reductn | | | | | | | | | | | | |
| Spillback Cap Reductn | | | | | | | | | | | | |
| Storage Cap Reductn | | | | | | | | | | | | |
| Reduced v/c Ratio | | | | | | | | | | | | |

| Lane Group | Ø3 |
|---|---|
| Minimum Split (s) | 15.0 |
| Total Split (s) | 15.0 |
| Total Split (%) | 16% |
| Maximum Green (s) | 13.0 |
| Yellow Time (s) | 2.0 |
| All-Red Time (s) | 0.0 |
| Lost Time Adjust (s) | |
| Total Lost Time (s) | |
| Lead/Lag | Lead |
| Lead-Lag Optimize? | Yes |
| Vehicle Extension (s) | 3.0 |
| Recall Mode | None |
| Walk Time (s) | |
| Flash Dont Walk (s) | |
| Pedestrian Calls (#/hr) | |
| Act Effct Green (s) | |
| Actuated g/C Ratio | |
| v/c Ratio | |
| Control Delay | |
| Queue Delay | |
| Total Delay | |
| LOS | |
| Approach Delay | |
| Approach LOS | |
| 90th %ile Green (s) | 0.0 |
| 90th %ile Term Code | Skip |
| 70th %ile Green (s) | 0.0 |
| 70th %ile Term Code | Skip |
| 50th %ile Green (s) | 0.0 |
| 50th %ile Term Code | Skip |
| 30th %ile Green (s) | 0.0 |
| 30th %ile Term Code | Skip |
| 10th %ile Green (s) | 0.0 |
| 10th %ile Term Code | Skip |
| Stops (vph) | |
| Fuel Used(gal) | |
| CO Emissions (g/hr) | |
| NOx Emissions (g/hr) | |
| VOC Emissions (g/hr) | |
| Dilemma Vehicles (#) | |
| Queue Length 50th (ft) | |
| Queue Length 95th (ft) | |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | |
| Starvation Cap Reductn | |
| Spillback Cap Reductn | |
| Storage Cap Reductn | |
| Reduced v/c Ratio | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 94.5 | |
| Actuated Cycle Length: 73.5 | |
| Natural Cycle: 85 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 0.00 | |
| Intersection Signal Delay: 0.0 | Intersection LOS: A |
| Intersection Capacity Utilization 0.0% | ICU Level of Service A |
| Analysis Period (min) 15 | |
| 90th %ile Actuated Cycle: 73.5 | |
| 70th %ile Actuated Cycle: 73.5 | |
| 50th %ile Actuated Cycle: 73.5 | |
| 30th %ile Actuated Cycle: 73.5 | |
| 10th %ile Actuated Cycle: 73.5 | |

Splits and Phases: 64: Scenic Hwy & Herring Pond Rd

| Movement | EBL | EBR | EBR2 | NWL2 | NWL | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | | | | | | | | |
| Lane Util. Factor | | | | | | | | | | | | |
| Frt | | | | | | | | | | | | |
| Flt Protected | | | | | | | | | | | | |
| Satd. Flow (prot) | | | | | | | | | | | | |
| Flt Permitted | | | | | | | | | | | | |
| Satd. Flow (perm) | | | | | | | | | | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Turn Type | Prot | | Perm | Perm | | Perm | Perm | | Perm | Perm | | |
| Protected Phases | 4 | | | | | | | 2 | | | 6 | |
| Permitted Phases | | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | | | | | | | | |
| Effective Green, g (s) | | | | | | | | | | | | |
| Actuated g/C Ratio | | | | | | | | | | | | |
| Clearance Time (s) | | | | | | | | | | | | |
| Vehicle Extension (s) | | | | | | | | | | | | |
| Lane Grp Cap (vph) | | | | | | | | | | | | |
| v/s Ratio Prot | | | | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | | | | | | | | | | | | |
| Uniform Delay, d1 | | | | | | | | | | | | |
| Progression Factor | | | | | | | | | | | | |
| Incremental Delay, d2 | | | | | | | | | | | | |
| Delay (s) | | | | | | | | | | | | |
| Level of Service | | | | | | | | | | | | |
| Approach Delay (s) | 0.0 | | | | 0.0 | | | 0.0 | | | 0.0 | |
| Approach LOS | A | | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 0.0 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.00 | | |
| Actuated Cycle Length (s) | 73.5 | Sum of lost time (s) | 15.5 |
| Intersection Capacity Utilization | 0.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

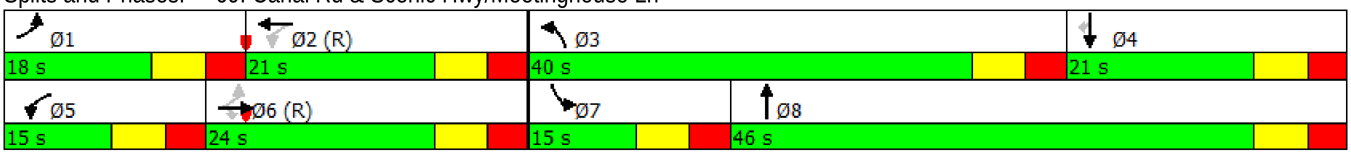
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 195 | 395 | 240 | 35 | 220 | 105 | 230 | 185 | 75 | 80 | 100 | 490 |
| Future Volume (vph) | 195 | 395 | 240 | 35 | 220 | 105 | 230 | 185 | 75 | 80 | 100 | 490 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | 0.952 | | | 0.957 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 1719 | 1810 | 1538 | 1719 | 1723 | 0 | 1719 | 1732 | 0 | 1719 | 1810 | 1538 |
| Flt Permitted | 0.180 | | | 0.326 | | | 0.950 | | | 0.950 | | |
| Satd. Flow (perm) | 326 | 1810 | 1538 | 590 | 1723 | 0 | 1719 | 1732 | 0 | 1719 | 1810 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 273 | | 20 | | | 24 | | | | 437 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 472 | | | 455 | | | 538 | | | 297 | |
| Travel Time (s) | | 10.7 | | | 10.3 | | | 12.2 | | | 6.8 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 429 | 261 | 38 | 239 | 114 | 250 | 201 | 82 | 87 | 109 | 533 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 212 | 429 | 261 | 38 | 353 | 0 | 250 | 283 | 0 | 87 | 109 | 533 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | 1 | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | Right | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | 20 | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 20 | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Detector Phase | 1 | 6 | 6 | 5 | 2 | | 3 | 8 | | 7 | 4 | 4 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 10.0 | 10.0 | 10.0 | 4.0 | 10.0 | | 4.0 | 10.0 | | 4.0 | 10.0 | 10.0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 17.0 | 17.0 | 17.0 | 11.0 | 17.0 | | 11.0 | 17.0 | | 11.0 | 17.0 | 17.0 |
| Total Split (s) | 18.0 | 24.0 | 24.0 | 15.0 | 21.0 | | 40.0 | 46.0 | | 15.0 | 21.0 | 21.0 |
| Total Split (%) | 18.0% | 24.0% | 24.0% | 15.0% | 21.0% | | 40.0% | 46.0% | | 15.0% | 21.0% | 21.0% |
| Maximum Green (s) | 11.0 | 17.0 | 17.0 | 8.0 | 14.0 | | 33.0 | 39.0 | | 8.0 | 14.0 | 14.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lead/Lag | Lead | Lag | Lag | Lead | Lag | | Lead | Lag | | Lead | Lag | Lag |
| Lead-Lag Optimize? | Yes | Yes | Yes | Yes | Yes | | Yes | Yes | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | None | C-Max | C-Max | None | C-Max | | None | None | | None | None | None |
| Act Effct Green (s) | 40.2 | 33.1 | 33.1 | 29.7 | 22.9 | | 19.9 | 32.2 | | 7.7 | 17.3 | 17.3 |
| Actuated g/C Ratio | 0.40 | 0.33 | 0.33 | 0.30 | 0.23 | | 0.20 | 0.32 | | 0.08 | 0.17 | 0.17 |
| v/c Ratio | 0.72 | 0.72 | 0.38 | 0.15 | 0.86 | | 0.73 | 0.49 | | 0.66 | 0.35 | 0.85 |
| Control Delay | 39.2 | 43.5 | 5.9 | 24.1 | 60.5 | | 49.6 | 27.2 | | 68.7 | 38.2 | 21.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | 39.2 | 43.5 | 5.9 | 24.1 | 60.5 | | 49.6 | 27.2 | | 68.7 | 38.2 | 21.9 |
| LOS | D | D | A | C | E | | D | C | | E | D | C |
| Approach Delay | | 31.6 | | | 56.9 | | | 37.7 | | | 29.9 | |
| Approach LOS | | C | | | E | | | D | | | C | |
| 90th %ile Green (s) | 11.0 | 17.0 | 17.0 | 8.0 | 14.0 | | 27.0 | 39.0 | | 8.0 | 20.0 | 20.0 |
| 90th %ile Term Code | Max | Coord | Coord | Max | Coord | | Gap | Hold | | Max | Max | Max |
| 70th %ile Green (s) | 11.0 | 17.2 | 17.2 | 7.8 | 14.0 | | 22.9 | 39.0 | | 8.0 | 24.1 | 24.1 |
| 70th %ile Term Code | Max | Coord | Coord | Gap | Coord | | Gap | Hold | | Max | Max | Max |
| 50th %ile Green (s) | 15.3 | 25.5 | 25.5 | 6.8 | 17.0 | | 19.9 | 31.7 | | 8.0 | 19.8 | 19.8 |
| 50th %ile Term Code | Gap | Coord | Coord | Gap | Coord | | Gap | Hold | | Max | Gap | Gap |
| 30th %ile Green (s) | 12.1 | 49.5 | 49.5 | 0.0 | 30.4 | | 17.0 | 21.5 | | 8.0 | 12.5 | 12.5 |
| 30th %ile Term Code | Gap | Coord | Coord | Skip | Coord | | Gap | Hold | | Max | Gap | Gap |
| 10th %ile Green (s) | 10.0 | 56.2 | 56.2 | 0.0 | 39.2 | | 12.8 | 29.8 | | 0.0 | 10.0 | 10.0 |
| 10th %ile Term Code | Min | Coord | Coord | Skip | Coord | | Gap | Hold | | Skip | Min | Min |
| Stops (vph) | 120 | 249 | 27 | 27 | 204 | | 208 | 183 | | 74 | 83 | 108 |
| Fuel Used(gal) | 3 | 6 | 1 | 0 | 6 | | 4 | 4 | | 2 | 2 | 6 |
| CO Emissions (g/hr) | 205 | 442 | 92 | 31 | 439 | | 310 | 248 | | 145 | 135 | 431 |
| NOx Emissions (g/hr) | 40 | 86 | 18 | 6 | 85 | | 60 | 48 | | 28 | 26 | 84 |
| VOC Emissions (g/hr) | 48 | 103 | 21 | 7 | 102 | | 72 | 57 | | 34 | 31 | 100 |
| Dilemma Vehicles (#) | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Queue Length 50th (ft) | 92 | 268 | 0 | 15 | ~254 | | 151 | 133 | | 55 | 60 | 53 |
| Queue Length 95th (ft) | #224 | #555 | 60 | 40 | #468 | | 216 | 188 | | #123 | 110 | #233 |
| Internal Link Dist (ft) | | 392 | | | 375 | | | 458 | | | 217 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 299 | 598 | 691 | 272 | 410 | | 567 | 690 | | 137 | 332 | 639 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.71 | 0.72 | 0.38 | 0.14 | 0.86 | | 0.44 | 0.41 | | 0.64 | 0.33 | 0.83 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 100 | |

Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 36.3 Intersection LOS: D
Intersection Capacity Utilization 78.6% ICU Level of Service D
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 69: Canal Rd & Scenic Hwy/Meetinghouse Ln



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 195 | 395 | 240 | 35 | 220 | 105 | 230 | 185 | 75 | 80 | 100 | 490 |
| Future Volume (vph) | 195 | 395 | 240 | 35 | 220 | 105 | 230 | 185 | 75 | 80 | 100 | 490 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.95 | | 1.00 | 0.96 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1538 | 1719 | 1722 | | 1719 | 1731 | | 1719 | 1810 | 1538 |
| Flt Permitted | 0.18 | 1.00 | 1.00 | 0.33 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 326 | 1810 | 1538 | 589 | 1722 | | 1719 | 1731 | | 1719 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 212 | 429 | 261 | 38 | 239 | 114 | 250 | 201 | 82 | 87 | 109 | 533 |
| RTOR Reduction (vph) | 0 | 0 | 186 | 0 | 16 | 0 | 0 | 16 | 0 | 0 | 0 | 355 |
| Lane Group Flow (vph) | 212 | 429 | 75 | 38 | 337 | 0 | 250 | 267 | 0 | 87 | 109 | 178 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | | Prot | NA | | Prot | NA | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | 6 | | 6 | 2 | | | | | | | | 4 |
| Actuated Green, G (s) | 40.4 | 28.9 | 28.9 | 26.0 | 21.5 | | 19.9 | 32.2 | | 6.4 | 18.7 | 18.7 |
| Effective Green, g (s) | 40.4 | 28.9 | 28.9 | 26.0 | 21.5 | | 19.9 | 32.2 | | 6.4 | 18.7 | 18.7 |
| Actuated g/C Ratio | 0.40 | 0.29 | 0.29 | 0.26 | 0.22 | | 0.20 | 0.32 | | 0.06 | 0.19 | 0.19 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | 7.0 | | 7.0 | 7.0 | 7.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 297 | 523 | 444 | 203 | 370 | | 342 | 557 | | 110 | 338 | 287 |
| v/s Ratio Prot | c0.08 | c0.24 | | 0.01 | 0.20 | | c0.15 | 0.15 | | 0.05 | 0.06 | |
| v/s Ratio Perm | 0.20 | | 0.05 | 0.04 | | | | | | | | c0.12 |
| v/c Ratio | 0.71 | 0.82 | 0.17 | 0.19 | 0.91 | | 0.73 | 0.48 | | 0.79 | 0.32 | 0.62 |
| Uniform Delay, d1 | 22.6 | 33.1 | 26.6 | 28.3 | 38.3 | | 37.5 | 27.2 | | 46.1 | 35.2 | 37.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 7.9 | 13.5 | 0.8 | 0.4 | 29.0 | | 7.8 | 0.7 | | 31.0 | 0.6 | 3.9 |
| Delay (s) | 30.5 | 46.6 | 27.4 | 28.8 | 67.3 | | 45.4 | 27.8 | | 77.1 | 35.7 | 41.3 |
| Level of Service | C | D | C | C | E | | D | C | | E | D | D |
| Approach Delay (s) | | 37.3 | | | 63.6 | | | 36.1 | | | 44.8 | |
| Approach LOS | | D | | | E | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 43.2 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 100.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 78.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 340 | 115 | 660 | 10 |
| Future Volume (vph) | 0 | 0 | 340 | 115 | 660 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | 0.998 | |
| Flt Protected | | | 0.950 | | | |
| Satd. Flow (prot) | 0 | 0 | 1719 | 1810 | 1806 | 0 |
| Flt Permitted | | | 0.950 | | | |
| Satd. Flow (perm) | 0 | 0 | 1719 | 1810 | 1806 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 326 | | | 356 | 559 | |
| Travel Time (s) | 7.4 | | | 8.1 | 12.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 370 | 125 | 717 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 370 | 125 | 728 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Sign Control | Stop | | | Free | Free | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 60.8% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 0 | 0 | 340 | 115 | 660 | 10 |
| Future Volume (Veh/h) | 0 | 0 | 340 | 115 | 660 | 10 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 0 | 370 | 125 | 717 | 11 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 886 | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1588 | 722 | 728 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1588 | 722 | 728 | | | |
| tC, single (s) | 6.4 | 6.2 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 100 | 57 | | | |
| cM capacity (veh/h) | 67 | 422 | 862 | | | |

| Direction, Lane # | NB 1 | NB 2 | SB 1 |
|---|---|---|---|
| Volume Total | 370 | 125 | 728 |
| Volume Left | 370 | 0 | 0 |
| Volume Right | 0 | 0 | 11 |
| cSH | 862 | 1700 | 1700 |
| Volume to Capacity | 0.43 | 0.07 | 0.43 |
| Queue Length 95th (ft) | 54 | 0 | 0 |
| Control Delay (s) | 12.3 | 0.0 | 0.0 |
| Lane LOS | B | | |
| Approach Delay (s) | 9.2 | | 0.0 |
| Approach LOS | | | |

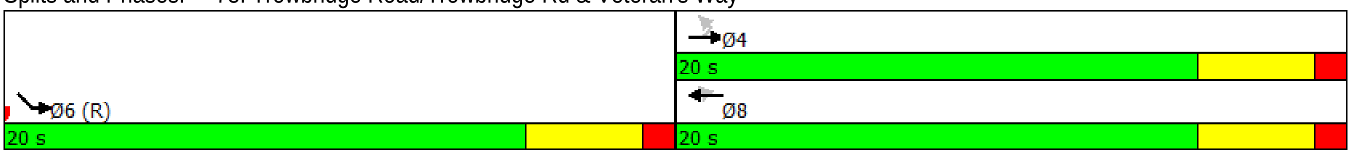
| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.7 | | |
| Intersection Capacity Utilization | 60.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 425 | 285 | 30 | 560 | 50 |
| Future Volume (vph) | 20 | 425 | 285 | 30 | 560 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 2 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 |
| Frt | | | | 0.850 | 0.988 | |
| Flt Protected | | 0.998 | | | 0.956 | |
| Satd. Flow (prot) | 0 | 1806 | 1810 | 1538 | 3316 | 0 |
| Flt Permitted | | 0.976 | | | 0.956 | |
| Satd. Flow (perm) | 0 | 1766 | 1810 | 1538 | 3316 | 0 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 33 | 28 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 742 | 276 | | 701 | |
| Travel Time (s) | | 16.9 | 6.3 | | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 462 | 310 | 33 | 609 | 54 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 484 | 310 | 33 | 663 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | |
| Detector Template | Left | Thru | Thru | Right | Left | |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | |
| Maximum Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | Min | Min | Min | Min | C-Min | |
| Act Effct Green (s) | | 14.5 | 14.5 | 14.5 | 16.5 | |
| Actuated g/C Ratio | | 0.36 | 0.36 | 0.36 | 0.41 | |
| v/c Ratio | | 0.76 | 0.47 | 0.06 | 0.48 | |
| Control Delay | | 20.7 | 12.1 | 4.0 | 10.2 | |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | | 20.7 | 12.1 | 4.0 | 10.2 | |
| LOS | | C | B | A | B | |
| Approach Delay | | 20.7 | 11.3 | | 10.2 | |
| Approach LOS | | C | B | | B | |
| 90th %ile Green (s) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | |
| 90th %ile Term Code | Max | Max | Max | Max | Coord | |
| 70th %ile Green (s) | 16.1 | 16.1 | 16.1 | 16.1 | 14.9 | |
| 70th %ile Term Code | Max | Max | Hold | Hold | Coord | |
| 50th %ile Green (s) | 16.5 | 16.5 | 16.5 | 16.5 | 14.5 | |
| 50th %ile Term Code | Gap | Gap | Hold | Hold | Coord | |
| 30th %ile Green (s) | 13.8 | 13.8 | 13.8 | 13.8 | 17.2 | |
| 30th %ile Term Code | Gap | Gap | Hold | Hold | Coord | |
| 10th %ile Green (s) | 10.5 | 10.5 | 10.5 | 10.5 | 20.5 | |
| 10th %ile Term Code | Gap | Gap | Hold | Hold | Coord | |
| Stops (vph) | | 346 | 197 | 10 | 400 | |
| Fuel Used(gal) | | 6 | 2 | 0 | 7 | |
| CO Emissions (g/hr) | | 444 | 168 | 10 | 476 | |
| NOx Emissions (g/hr) | | 86 | 33 | 2 | 93 | |
| VOC Emissions (g/hr) | | 103 | 39 | 2 | 110 | |
| Dilemma Vehicles (#) | | 0 | 0 | 0 | 0 | |
| Queue Length 50th (ft) | | 81 | 46 | 0 | 55 | |
| Queue Length 95th (ft) | | #201 | 96 | 11 | 86 | |
| Internal Link Dist (ft) | | 662 | 196 | | 621 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 698 | 715 | 628 | 1412 | |
| Starvation Cap Reductn | | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | | 0.69 | 0.43 | 0.05 | 0.47 | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 40 | |
| Actuated Cycle Length: 40 | |
| Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green | |
| Natural Cycle: 40 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.76 | |
| Intersection Signal Delay: 13.8 | Intersection LOS: B |
| Intersection Capacity Utilization 63.7% | ICU Level of Service B |
| Analysis Period (min) 15 | |
| # 95th percentile volume exceeds capacity, queue may be longer. | |
| Queue shown is maximum after two cycles. | |

Splits and Phases: 78: Trowbridge Road/Trowbridge Rd & Veteran's Way



# HCM Signalized Intersection Capacity Analysis
## 78: Trowbridge Road/Trowbridge Rd & Veteran's Way

02/16/2018

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 425 | 285 | 30 | 560 | 50 |
| Future Volume (vph) | 20 | 425 | 285 | 30 | 560 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 0.97 | |
| Frt | | 1.00 | 1.00 | 0.85 | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (prot) | | 1805 | 1810 | 1538 | 3315 | |
| Flt Permitted | | 0.98 | 1.00 | 1.00 | 0.96 | |
| Satd. Flow (perm) | | 1766 | 1810 | 1538 | 3315 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 462 | 310 | 33 | 609 | 54 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 21 | 16 | 0 |
| Lane Group Flow (vph) | 0 | 484 | 310 | 12 | 647 | 0 |
| Turn Type | Perm | NA | NA | Perm | Prot | |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | |
| Actuated Green, G (s) | | 14.5 | 14.5 | 14.5 | 16.5 | |
| Effective Green, g (s) | | 14.5 | 14.5 | 14.5 | 16.5 | |
| Actuated g/C Ratio | | 0.36 | 0.36 | 0.36 | 0.41 | |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 640 | 656 | 557 | 1367 | |
| v/s Ratio Prot | | | 0.17 | | c0.20 | |
| v/s Ratio Perm | | c0.27 | | 0.01 | | |
| v/c Ratio | | 0.76 | 0.47 | 0.02 | 0.47 | |
| Uniform Delay, d1 | | 11.2 | 9.8 | 8.2 | 8.6 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 5.1 | 0.5 | 0.0 | 1.2 | |
| Delay (s) | | 16.3 | 10.3 | 8.2 | 9.8 | |
| Level of Service | | B | B | A | A | |
| Approach Delay (s) | | 16.3 | 10.1 | | 9.8 | |
| Approach LOS | | B | B | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 12.0 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 63.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 1450 | 5 | 5 | 1030 | 5 | 5 |
| Future Volume (vph) | 1450 | 5 | 5 | 1030 | 5 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | 0.932 | |
| Flt Protected | | | 0.950 | | 0.976 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1646 | 0 |
| Flt Permitted | | | 0.950 | | 0.976 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1646 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1013 | | | 317 | 951 | |
| Travel Time (s) | 23.0 | | | 7.2 | 21.6 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1576 | 5 | 5 | 1120 | 5 | 5 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 1576 | 5 | 5 | 1120 | 10 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 86.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 1450 | 5 | 5 | 1030 | 5 | 5 |
| Future Volume (Veh/h) | 1450 | 5 | 5 | 1030 | 5 | 5 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 1576 | 5 | 5 | 1120 | 5 | 5 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | 1013 | | | | | |
| pX, platoon unblocked | | | 0.39 | | 0.39 | 0.39 |
| vC, conflicting volume | | | 1581 | | 2706 | 1576 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 1710 | | 4628 | 1697 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 96 | | 0 | 88 |
| cM capacity (veh/h) | | | 140 | | 0 | 43 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total | 1576 | 5 | 5 | 1120 | 10 |
| Volume Left | 0 | 0 | 5 | 0 | 5 |
| Volume Right | 0 | 5 | 0 | 0 | 5 |
| cSH | 1700 | 1700 | 140 | 1700 | 1 |
| Volume to Capacity | 0.93 | 0.00 | 0.04 | 0.66 | 11.59 |
| Queue Length 95th (ft) | 0 | 0 | 3 | 0 | Err |
| Control Delay (s) | 0.0 | 0.0 | 31.7 | 0.0 | Err |
| Lane LOS | | | D | | F |
| Approach Delay (s) | 0.0 | | 0.1 | | Err |
| Approach LOS | | | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 36.9 | | |
| Intersection Capacity Utilization | 86.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 1810 | 1810 | 1810 | 3438 | 3438 | 0 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 1810 | 1810 | 1810 | 3438 | 3438 | 0 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | | | | | |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 393 | | | 1366 | 1052 | |
| Travel Time (s) | 8.9 | | | 31.0 | 23.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | 1 | 1 | 2 | 2 | |
| Detector Template | Left | Right | Left | Thru | Thru | |
| Leading Detector (ft) | 20 | 20 | 20 | 100 | 100 | |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 20 | 20 | 6 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | Perm | Prot | | | |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | |
| Detector Phase | 4 | 4 | 5 | 2 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 7.0 | 7.0 | 7.0 | 15.0 | 15.0 | |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Minimum Split (s) | 12.0 | 12.0 | 12.0 | 23.0 | 23.0 | |
| Total Split (s) | 19.0 | 19.0 | 19.0 | 62.0 | 62.0 | |
| Total Split (%) | 19.0% | 19.0% | 19.0% | 62.0% | 62.0% | |
| Maximum Green (s) | 14.0 | 14.0 | 15.0 | 55.0 | 55.0 | |
| Yellow Time (s) | 3.0 | 3.0 | 3.0 | 5.5 | 5.5 | |
| All-Red Time (s) | 2.0 | 2.0 | 1.0 | 1.5 | 1.5 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | 4.0 | 7.0 | 7.0 | |
| Lead/Lag | | | Lead | | Lag | |
| Lead-Lag Optimize? | | | Yes | | Yes | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | None | None | Max | Max | |
| Act Effct Green (s) | | | | | | |
| Actuated g/C Ratio | | | | | | |
| v/c Ratio | | | | | | |
| Control Delay | | | | | | |
| Queue Delay | | | | | | |
| Total Delay | | | | | | |
| LOS | | | | | | |
| Approach Delay | | | | | | |
| Approach LOS | | | | | | |
| 90th %ile Green (s) | 0.0 | 0.0 | 0.0 | 70.0 | 70.0 | |
| 90th %ile Term Code | Skip | Skip | Skip | Dwell | Dwell | |
| 70th %ile Green (s) | 0.0 | 0.0 | 0.0 | 70.0 | 70.0 | |
| 70th %ile Term Code | Skip | Skip | Skip | Dwell | Dwell | |
| 50th %ile Green (s) | 0.0 | 0.0 | 0.0 | 70.0 | 70.0 | |
| 50th %ile Term Code | Skip | Skip | Skip | Dwell | Dwell | |
| 30th %ile Green (s) | 0.0 | 0.0 | 0.0 | 70.0 | 70.0 | |
| 30th %ile Term Code | Skip | Skip | Skip | Dwell | Dwell | |
| 10th %ile Green (s) | 0.0 | 0.0 | 0.0 | 70.0 | 70.0 | |
| 10th %ile Term Code | Skip | Skip | Skip | Dwell | Dwell | |
| Stops (vph) | | | | | | |
| Fuel Used(gal) | | | | | | |
| CO Emissions (g/hr) | | | | | | |
| NOx Emissions (g/hr) | | | | | | |
| VOC Emissions (g/hr) | | | | | | |
| Dilemma Vehicles (#) | | | | | | |
| Queue Length 50th (ft) | | | | | | |
| Queue Length 95th (ft) | | | | | | |
| Internal Link Dist (ft) | 313 | | | 1286 | 972 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | | | | | |
| Starvation Cap Reductn | | | | | | |
| Spillback Cap Reductn | | | | | | |
| Storage Cap Reductn | | | | | | |
| Reduced v/c Ratio | | | | | | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 100 | |

| | |
|---|---|
| Actuated Cycle Length: 77 | |
| Natural Cycle: 50 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 0.00 | |
| Intersection Signal Delay: 0.0 | Intersection LOS: A |
| Intersection Capacity Utilization 0.0% | ICU Level of Service A |
| Analysis Period (min) 15 | |
| 90th %ile Actuated Cycle: 77 | |
| 70th %ile Actuated Cycle: 77 | |
| 50th %ile Actuated Cycle: 77 | |
| 30th %ile Actuated Cycle: 77 | |
| 10th %ile Actuated Cycle: 77 | |

Splits and Phases: 89: Scenic Hwy & Edgehill Rd

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | | |
| Lane Util. Factor | | | | | | |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | | | | | | |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | | | | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Turn Type | Prot | Perm | Prot | | | |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | |
| Actuated Green, G (s) | | | | | | |
| Effective Green, g (s) | | | | | | |
| Actuated g/C Ratio | | | | | | |
| Clearance Time (s) | | | | | | |
| Vehicle Extension (s) | | | | | | |
| Lane Grp Cap (vph) | | | | | | |
| v/s Ratio Prot | | | | | | |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | | | | | | |
| Uniform Delay, d1 | | | | | | |
| Progression Factor | | | | | | |
| Incremental Delay, d2 | | | | | | |
| Delay (s) | | | | | | |
| Level of Service | | | | | | |
| Approach Delay (s) | 0.0 | | | 0.0 | 0.0 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 0.0 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.00 | | |
| Actuated Cycle Length (s) | 77.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 0.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

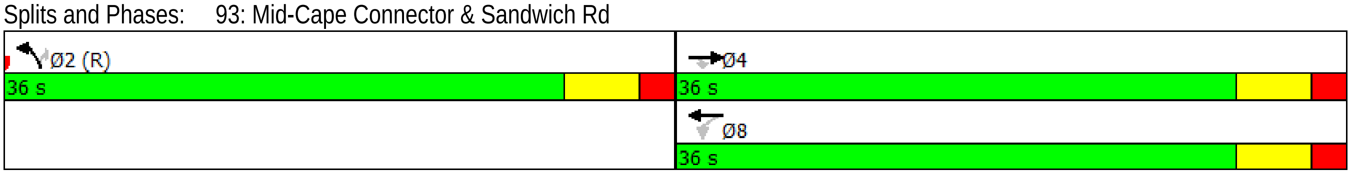
| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 240 | 1270 | 65 | 715 | 230 | 370 |
| Future Volume (vph) | 240 | 1270 | 65 | 715 | 230 | 370 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.576 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1042 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 1091 | | | | 402 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 282 | | | 234 | 445 | |
| Travel Time (s) | 6.4 | | | 5.3 | 10.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 261 | 1380 | 71 | 777 | 250 | 402 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 261 | 1380 | 71 | 777 | 250 | 402 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Turn Type | NA | Perm | Perm | NA | Prot | Perm |
| Protected Phases | 4 | | | 8 | 2 | |
| Permitted Phases | | 4 | 8 | | | 2 |
| Minimum Split (s) | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 |
| Total Split (s) | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% |
| Maximum Green (s) | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Actuated g/C Ratio | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| v/c Ratio | 0.35 | 1.08 | 0.16 | 1.03 | 0.35 | 0.46 |
| Control Delay | 16.0 | 58.3 | 14.5 | 64.6 | 16.1 | 3.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 16.0 | 58.3 | 14.5 | 64.6 | 16.1 | 3.5 |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| LOS | B | E | B | E | B | A |
| Approach Delay | 51.5 | | | 60.4 | 8.4 | |
| Approach LOS | D | | | E | A | |
| Stops (vph) | 156 | 289 | 40 | 588 | 150 | 33 |
| Fuel Used(gal) | 3 | 26 | 1 | 18 | 3 | 3 |
| CO Emissions (g/hr) | 236 | 1804 | 62 | 1247 | 220 | 207 |
| NOx Emissions (g/hr) | 46 | 351 | 12 | 243 | 43 | 40 |
| VOC Emissions (g/hr) | 55 | 418 | 14 | 289 | 51 | 48 |
| Dilemma Vehicles (#) | 0 | 0 | 0 | 0 | 0 | 0 |
| Queue Length 50th (ft) | 76 | ~385 | 19 | ~378 | 73 | 0 |
| Queue Length 95th (ft) | 130 | #629 | 45 | #580 | 127 | 48 |
| Internal Link Dist (ft) | 202 | | | 154 | 365 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 754 | 1277 | 434 | 754 | 716 | 875 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.35 | 1.08 | 0.16 | 1.03 | 0.35 | 0.46 |

Intersection Summary

Area Type: Other
Cycle Length: 72
Actuated Cycle Length: 72
Offset: 0 (0%), Referenced to phase 2:NBL and 6:, Start of Green
Natural Cycle: 100
Control Type: Pretimed
Maximum v/c Ratio: 1.08
Intersection Signal Delay: 45.0 Intersection LOS: D
Intersection Capacity Utilization 113.6% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 93: Mid-Cape Connector & Sandwich Rd



| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 240 | 1270 | 65 | 715 | 230 | 370 |
| Future Volume (vph) | 240 | 1270 | 65 | 715 | 230 | 370 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | 1.00 | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | 1.00 | 0.58 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1810 | 1538 | 1042 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 261 | 1380 | 71 | 777 | 250 | 402 |
| RTOR Reduction (vph) | 0 | 636 | 0 | 0 | 0 | 235 |
| Lane Group Flow (vph) | 261 | 744 | 71 | 777 | 250 | 168 |
| Turn Type | NA | Perm | Perm | NA | Prot | Perm |
| Protected Phases | 4 | | | 8 | 2 | |
| Permitted Phases | | 4 | 8 | | | 2 |
| Actuated Green, G (s) | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Effective Green, g (s) | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| Actuated g/C Ratio | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| Clearance Time (s) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Grp Cap (vph) | 754 | 640 | 434 | 754 | 716 | 640 |
| v/s Ratio Prot | 0.14 | | | 0.43 | c0.15 | |
| v/s Ratio Perm | | c0.48 | 0.07 | | | 0.11 |
| v/c Ratio | 0.35 | 1.16 | 0.16 | 1.03 | 0.35 | 0.26 |
| Uniform Delay, d1 | 14.3 | 21.0 | 13.1 | 21.0 | 14.3 | 13.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.3 | 89.3 | 0.8 | 40.8 | 1.3 | 1.0 |
| Delay (s) | 15.6 | 110.3 | 14.0 | 61.8 | 15.7 | 14.7 |
| Level of Service | B | F | B | E | B | B |
| Approach Delay (s) | 95.2 | | | 57.8 | 15.1 | |
| Approach LOS | F | | | E | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 68.5 | HCM 2000 Level of Service | E |
| HCM 2000 Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 72.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 113.6% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

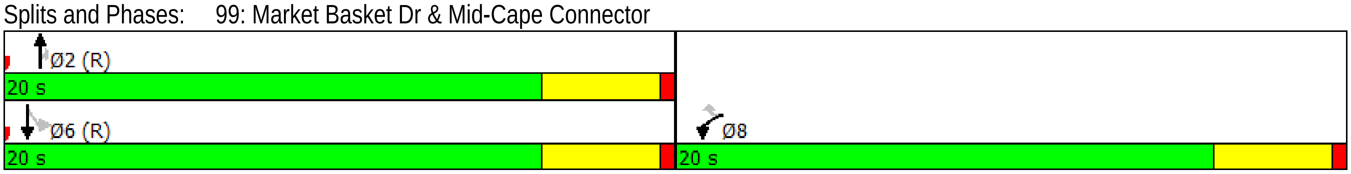
| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 60 | 55 | 545 | 55 | 60 | 1275 |
| Future Volume (vph) | 60 | 55 | 545 | 55 | 60 | 1275 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 |
| Ped Bike Factor | 0.99 | | | | | |
| Frt | | 0.850 | | 0.850 | | |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 3335 | 1538 | 1810 | 1538 | 1719 | 3438 |
| Flt Permitted | 0.950 | | | | 0.250 | |
| Satd. Flow (perm) | 3314 | 1538 | 1810 | 1538 | 452 | 3438 |
| Right Turn on Red | | Yes | | Yes | | |
| Satd. Flow (RTOR) | | 60 | | 60 | | |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 572 | | 399 | | | 426 |
| Travel Time (s) | 13.0 | | 9.1 | | | 9.7 |
| Confl. Peds. (#/hr) | 5 | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 65 | 60 | 592 | 60 | 65 | 1386 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 65 | 60 | 592 | 60 | 65 | 1386 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 24 | | 12 | | | 12 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Turn Type | Prot | Perm | NA | Perm | Perm | NA |
| Protected Phases | 8 | | 2 | | | 6 |
| Permitted Phases | | 8 | | 2 | 6 | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (%) | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% | 50.0% |
| Maximum Green (s) | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 |
| Actuated g/C Ratio | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| v/c Ratio | 0.05 | 0.09 | 0.82 | 0.09 | 0.36 | 1.01 |
| Control Delay | 7.5 | 3.3 | 23.6 | 3.3 | 15.5 | 42.3 |

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 7.5 | 3.3 | 23.6 | 3.3 | 15.5 | 42.3 |
| LOS | A | A | C | A | B | D |
| Approach Delay | 5.5 | | 21.7 | | | 41.1 |
| Approach LOS | A | | C | | | D |
| Stops (vph) | 36 | 14 | 420 | 14 | 48 | 1009 |
| Fuel Used(gal) | 1 | 0 | 7 | 0 | 1 | 25 |
| CO Emissions (g/hr) | 39 | 25 | 464 | 20 | 60 | 1762 |
| NOx Emissions (g/hr) | 8 | 5 | 90 | 4 | 12 | 343 |
| VOC Emissions (g/hr) | 9 | 6 | 107 | 5 | 14 | 408 |
| Dilemma Vehicles (#) | 0 | 0 | 0 | 0 | 0 | 0 |
| Queue Length 50th (ft) | 4 | 0 | 110 | 0 | 10 | ~155 |
| Queue Length 95th (ft) | 11 | 14 | #257 | 14 | 35 | #285 |
| Internal Link Dist (ft) | 492 | | 319 | | | 346 |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | 1334 | 651 | 724 | 651 | 180 | 1375 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.05 | 0.09 | 0.82 | 0.09 | 0.36 | 1.01 |

Intersection Summary

Area Type: Other
Cycle Length: 40
Actuated Cycle Length: 40
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
Natural Cycle: 50
Control Type: Pretimed
Maximum v/c Ratio: 1.01
Intersection Signal Delay: 33.4 Intersection LOS: C
Intersection Capacity Utilization 45.4% ICU Level of Service A
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 99: Market Basket Dr & Mid-Cape Connector



| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 60 | 55 | 545 | 55 | 60 | 1275 |
| Future Volume (vph) | 60 | 55 | 545 | 55 | 60 | 1275 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 |
| Frpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 3335 | 1538 | 1810 | 1538 | 1719 | 3438 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.25 | 1.00 |
| Satd. Flow (perm) | 3335 | 1538 | 1810 | 1538 | 452 | 3438 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 65 | 60 | 592 | 60 | 65 | 1386 |
| RTOR Reduction (vph) | 0 | 36 | 0 | 36 | 0 | 0 |
| Lane Group Flow (vph) | 65 | 24 | 592 | 24 | 65 | 1386 |
| Confl. Peds. (#/hr) | 5 | | | | | |
| Turn Type | Prot | Perm | NA | Perm | Perm | NA |
| Protected Phases | 8 | | 2 | | | 6 |
| Permitted Phases | | 8 | | 2 | 6 | |
| Actuated Green, G (s) | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 |
| Effective Green, g (s) | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 |
| Actuated g/C Ratio | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Grp Cap (vph) | 1334 | 615 | 724 | 615 | 180 | 1375 |
| v/s Ratio Prot | c0.02 | | 0.33 | | | c0.40 |
| v/s Ratio Perm | | 0.02 | | 0.02 | 0.14 | |
| v/c Ratio | 0.05 | 0.04 | 0.82 | 0.04 | 0.36 | 1.01 |
| Uniform Delay, d1 | 7.3 | 7.3 | 10.7 | 7.3 | 8.4 | 12.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | 0.1 | 9.9 | 0.1 | 5.5 | 26.2 |
| Delay (s) | 7.4 | 7.4 | 20.6 | 7.4 | 14.0 | 38.2 |
| Level of Service | A | A | C | A | B | D |
| Approach Delay (s) | 7.4 | | 19.4 | | | 37.1 |
| Approach LOS | A | | B | | | D |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 30.3 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 280 | 665 | 645 | 0 | 120 | 355 |
| Future Volume (vph) | 280 | 665 | 645 | 0 | 120 | 355 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | |
| Flt Protected | 0.950 | | | | | 0.988 |
| Satd. Flow (prot) | 1719 | 1538 | 1810 | 1810 | 0 | 1788 |
| Flt Permitted | 0.950 | | | | | 0.988 |
| Satd. Flow (perm) | 1719 | 1538 | 1810 | 1810 | 0 | 1788 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 263 | | 109 | | | 1820 |
| Travel Time (s) | 6.0 | | 2.5 | | | 41.4 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 304 | 723 | 701 | 0 | 130 | 386 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 304 | 723 | 701 | 0 | 0 | 516 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 84.8% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 280 | 665 | 645 | 0 | 120 | 355 |
| Future Volume (Veh/h) | 280 | 665 | 645 | 0 | 120 | 355 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 304 | 723 | 701 | 0 | 130 | 386 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1347 | 701 | | | 701 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1347 | 701 | | | 701 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 0 | 0 | | | 85 | |
| cM capacity (veh/h) | 140 | 434 | | | 882 | |

| Direction, Lane # | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|
| Volume Total | 304 | 723 | 701 | 0 | 516 |
| Volume Left | 304 | 0 | 0 | 0 | 130 |
| Volume Right | 0 | 723 | 0 | 0 | 0 |
| cSH | 140 | 434 | 1700 | 1700 | 882 |
| Volume to Capacity | 2.17 | 1.67 | 0.41 | 0.00 | 0.15 |
| Queue Length 95th (ft) | 626 | 1064 | 0 | 0 | 13 |
| Control Delay (s) | 602.2 | 333.0 | 0.0 | 0.0 | 3.9 |
| Lane LOS | F | F | | | A |
| Approach Delay (s) | 412.7 | | 0.0 | | 3.9 |
| Approach LOS | F | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 189.8 | | |
| Intersection Capacity Utilization | 84.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 90 | 90 | 435 | 875 | 385 | 360 |
| Future Volume (vph) | 90 | 90 | 435 | 875 | 385 | 360 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | | 0.984 | | |
| Satd. Flow (prot) | 1719 | 1538 | 0 | 1781 | 1810 | 1538 |
| Flt Permitted | 0.950 | | | 0.984 | | |
| Satd. Flow (perm) | 1719 | 1538 | 0 | 1781 | 1810 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 482 | | | 1820 | 155 | |
| Travel Time (s) | 11.0 | | | 41.4 | 3.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 98 | 98 | 473 | 951 | 418 | 391 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 98 | 98 | 0 | 1424 | 418 | 391 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Sign Control | Stop | | | Free | Free | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 105.4% | ICU Level of Service G |
| Analysis Period (min) 15 | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 90 | 90 | 435 | 875 | 385 | 360 |
| Future Volume (Veh/h) | 90 | 90 | 435 | 875 | 385 | 360 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 98 | 98 | 473 | 951 | 418 | 391 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2315 | 418 | 418 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2315 | 418 | 418 | | | |
| tC, single (s) | 6.4 | 6.2 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 84 | 58 | | | |
| cM capacity (veh/h) | 24 | 629 | 1125 | | | |

| Direction, Lane # | EB 1 | EB 2 | NB 1 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total | 98 | 98 | 1424 | 418 | 391 |
| Volume Left | 98 | 0 | 473 | 0 | 0 |
| Volume Right | 0 | 98 | 0 | 0 | 391 |
| cSH | 24 | 629 | 1125 | 1700 | 1700 |
| Volume to Capacity | 4.15 | 0.16 | 0.42 | 0.25 | 0.23 |
| Queue Length 95th (ft) | Err | 14 | 53 | 0 | 0 |
| Control Delay (s) | Err | 11.8 | 10.2 | 0.0 | 0.0 |
| Lane LOS | F | B | B | | |
| Approach Delay (s) | 5005.4 | | 10.2 | 0.0 | |
| Approach LOS | F | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 409.9 | | |
| Intersection Capacity Utilization | 105.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | | | | | | | |
| Flt Protected | | | | | | | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 0 | 0 | 1810 | 0 | 0 | 1810 | 0 | 0 | 1810 | 0 |
| Flt Permitted | | | | | | | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 0 | 0 | 1810 | 0 | 0 | 1810 | 0 | 0 | 1810 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 622 | | | 556 | | | 536 | | | 177 | |
| Travel Time (s) | | 14.1 | | | 12.6 | | | 12.2 | | | 4.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 0.0% ICU Level of Service A

Analysis Period (min) 15

# HCM Unsignalized Intersection Capacity Analysis
## 106: Herring Pond Rd/Rte 3A & Long Pond Rd

02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Future Volume (Veh/h) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | | 100 | | |
| cM capacity (veh/h) | 1016 | 890 | 1076 | 1016 | 890 | 1076 | 1604 | | | 1604 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 0 | 0 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 0 |
| cSH | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.00 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | A | A | | |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Approach LOS | A | A | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 0.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Lane Group | NBL | NBT | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 175 | 305 | 420 | 570 | 470 | 495 |
| Future Volume (vph) | 175 | 305 | 420 | 570 | 470 | 495 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.922 | | 0.931 | |
| Flt Protected | | 0.982 | | | 0.976 | |
| Satd. Flow (prot) | 0 | 1777 | 1668 | 0 | 1644 | 0 |
| Flt Permitted | | 0.982 | | | 0.976 | |
| Satd. Flow (perm) | 0 | 1777 | 1668 | 0 | 1644 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 876 | 439 | | 613 | |
| Travel Time (s) | | 19.9 | 10.0 | | 13.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 190 | 332 | 457 | 620 | 511 | 538 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 522 | 1077 | 0 | 1049 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 149.2% | ICU Level of Service H |
| Analysis Period (min) 15 | |

| Movement | NBL | NBT | SBT | SBR | NEL | NER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 175 | 305 | 420 | 570 | 470 | 495 |
| Future Volume (Veh/h) | 175 | 305 | 420 | 570 | 470 | 495 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 190 | 332 | 457 | 620 | 511 | 538 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 457 | | | | 1479 | 767 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 457 | | | | 1479 | 767 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 83 | | | | 0 | 0 |
| cM capacity (veh/h) | 1088 | | | | 112 | 397 |

| Direction, Lane # | NB 1 | SB 1 | NE 1 |
|---|---|---|---|
| Volume Total | 522 | 1077 | 1049 |
| Volume Left | 190 | 0 | 511 |
| Volume Right | 0 | 620 | 538 |
| cSH | 1088 | 1700 | 178 |
| Volume to Capacity | 0.17 | 0.63 | 5.90 |
| Queue Length 95th (ft) | 16 | 0 | Err |
| Control Delay (s) | 4.5 | 0.0 | Err |
| Lane LOS | A | | F |
| Approach Delay (s) | 4.5 | 0.0 | Err |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3962.0 | | |
| Intersection Capacity Utilization | 149.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 50 | 5 | 5 | 155 | 0 | 5 | 0 | 15 | 10 | 0 | 5 |
| Future Volume (vph) | 0 | 50 | 5 | 5 | 155 | 0 | 5 | 0 | 15 | 10 | 0 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Ped Bike Factor | | | | | | | | | | | | |
| Frt | | 0.987 | | | | | | 0.897 | | | 0.958 | |
| Flt Protected | | | | | 0.999 | | | 0.988 | | | 0.967 | |
| Satd. Flow (prot) | 0 | 3393 | 0 | 0 | 3435 | 0 | 0 | 1604 | 0 | 0 | 1676 | 0 |
| Flt Permitted | | | | | 0.999 | | | 0.988 | | | 0.967 | |
| Satd. Flow (perm) | 0 | 3393 | 0 | 0 | 3435 | 0 | 0 | 1604 | 0 | 0 | 1676 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 366 | | | 498 | | | 307 | | | 1083 | |
| Travel Time (s) | | 8.3 | | | 11.3 | | | 7.0 | | | 24.6 | |
| Confl. Peds. (#/hr) | 300 | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 54 | 5 | 5 | 168 | 0 | 5 | 0 | 16 | 11 | 0 | 5 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 59 | 0 | 0 | 173 | 0 | 0 | 21 | 0 | 0 | 16 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 17.8% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 0 | 50 | 5 | 5 | 155 | 0 | 5 | 0 | 15 | 10 | 0 | 5 |
| Future Volume (Veh/h) | 0 | 50 | 5 | 5 | 155 | 0 | 5 | 0 | 15 | 10 | 0 | 5 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 54 | 5 | 5 | 168 | 0 | 5 | 0 | 16 | 11 | 0 | 5 |
| Pedestrians | | | | | | | | | | | 300 | |
| Lane Width (ft) | | | | | | | | | | | 12.0 | |
| Walking Speed (ft/s) | | | | | | | | | | | 4.0 | |
| Percent Blockage | | | | | | | | | | | 25 | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 468 | | | 59 | | | 156 | 534 | 30 | 521 | 537 | 384 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 468 | | | 59 | | | 156 | 534 | 30 | 521 | 537 | 384 |
| tC, single (s) | 4.2 | | | 4.2 | | | 7.6 | 6.6 | 7.0 | 7.6 | 6.6 | 7.0 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 99 | 100 | 98 | 96 | 100 | 99 |
| cM capacity (veh/h) | 802 | | | 1521 | | | 627 | 332 | 1029 | 257 | 331 | 454 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 36 | 23 | 61 | 112 | 21 | 16 |
| Volume Left | 0 | 0 | 5 | 0 | 5 | 11 |
| Volume Right | 0 | 5 | 0 | 0 | 16 | 5 |
| cSH | 1700 | 1700 | 1521 | 1700 | 893 | 297 |
| Volume to Capacity | 0.02 | 0.01 | 0.00 | 0.07 | 0.02 | 0.05 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 | 2 | 4 |
| Control Delay (s) | 0.0 | 0.0 | 0.6 | 0.0 | 9.1 | 17.8 |
| Lane LOS | | | A | | A | C |
| Approach Delay (s) | 0.0 | | 0.2 | | 9.1 | 17.8 |
| Approach LOS | | | | | A | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 17.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 510 | 5 | 20 | 915 | 0 | 0 |
| Future Volume (vph) | 510 | 5 | 20 | 915 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.999 | | | | | |
| Flt Protected | | | | 0.999 | | |
| Satd. Flow (prot) | 1808 | 0 | 0 | 1808 | 0 | 0 |
| Flt Permitted | | | | 0.999 | | |
| Satd. Flow (perm) | 1808 | 0 | 0 | 1808 | 0 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 493 | | | 456 | 1083 | |
| Travel Time (s) | 11.2 | | | 10.4 | 24.6 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 554 | 5 | 22 | 995 | 0 | 0 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 559 | 0 | 0 | 1017 | 0 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 67.5% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 510 | 5 | 20 | 915 | 0 | 0 |
| Future Volume (Veh/h) | 510 | 5 | 20 | 915 | 0 | 0 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 554 | 5 | 22 | 995 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 559 | | 1596 | 556 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 559 | | 1596 | 556 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 98 | | 100 | 100 |
| cM capacity (veh/h) | | | 997 | | 113 | 525 |

| Direction, Lane # | EB 1 | WB 1 |
|---|---|---|
| Volume Total | 559 | 1017 |
| Volume Left | 0 | 22 |
| Volume Right | 5 | 0 |
| cSH | 1700 | 997 |
| Volume to Capacity | 0.33 | 0.02 |
| Queue Length 95th (ft) | 0 | 2 |
| Control Delay (s) | 0.0 | 0.6 |
| Lane LOS | | A |
| Approach Delay (s) | 0.0 | 0.6 |
| Approach LOS | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.4 | | |
| Intersection Capacity Utilization | 67.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1800 | 5 | 625 | 5 | 5 | 5 | 1110 | 85 | 5 | 5 | 755 | 450 |
| Future Volume (vph) | 1800 | 5 | 625 | 5 | 5 | 5 | 1110 | 85 | 5 | 5 | 755 | 450 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.921 | | | 0.955 | | | 0.999 | | | | 0.850 |
| Flt Protected | 0.950 | 0.977 | | | 0.984 | | 0.950 | 0.959 | | | | |
| Satd. Flow (prot) | 1633 | 1547 | 0 | 0 | 1700 | 0 | 1633 | 1647 | 0 | 0 | 3438 | 1538 |
| Flt Permitted | 0.650 | 0.784 | | | 0.620 | | 0.154 | 0.143 | | | 0.951 | |
| Satd. Flow (perm) | 1117 | 1241 | 0 | 0 | 1071 | 0 | 265 | 246 | 0 | 0 | 3270 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 82 | | | 5 | | | 1 | | | | 417 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1957 | 5 | 679 | 5 | 5 | 5 | 1207 | 92 | 5 | 5 | 821 | 489 |
| Shared Lane Traffic (%) | 31% | | | | | | 48% | | | | | |
| Lane Group Flow (vph) | 1350 | 1291 | 0 | 0 | 15 | 0 | 628 | 676 | 0 | 0 | 826 | 489 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

## Lanes, Volumes, Timings
## 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge 02/16/2018

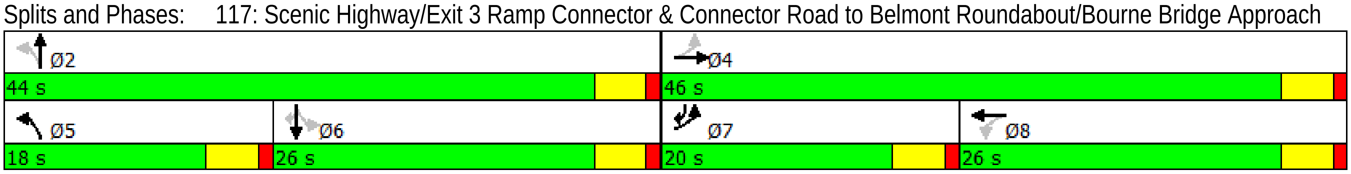
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 20.0 | 46.0 | | 26.0 | 26.0 | | 18.0 | 44.0 | | 26.0 | 26.0 | 20.0 |
| Total Split (%) | 22.2% | 51.1% | | 28.9% | 28.9% | | 20.0% | 48.9% | | 28.9% | 28.9% | 22.2% |
| Maximum Green (s) | 15.5 | 41.5 | | 21.5 | 21.5 | | 13.5 | 39.5 | | 21.5 | 21.5 | 15.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 41.5 | 41.5 | | | 9.3 | | 39.5 | 39.5 | | | 21.5 | 62.3 |
| Actuated g/C Ratio | 0.46 | 0.46 | | | 0.10 | | 0.44 | 0.44 | | | 0.24 | 0.69 |
| v/c Ratio | 1.87 | 1.75 | | | 0.13 | | 1.96 | 2.13 | | | 1.06 | 0.41 |
| Control Delay | 418.2 | 363.0 | | | 28.6 | | 462.2 | 537.0 | | | 83.2 | 3.1 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 418.2 | 363.0 | | | 28.6 | | 462.2 | 537.0 | | | 83.2 | 3.1 |
| LOS | F | F | | | C | | F | F | | | F | A |
| Approach Delay | | 391.2 | | | 28.6 | | | 501.0 | | | 53.4 | |
| Approach LOS | | F | | | C | | | F | | | D | |
| 90th %ile Green (s) | 15.5 | 41.5 | | 21.5 | 21.5 | | 13.5 | 39.5 | | 21.5 | 21.5 | 15.5 |
| 90th %ile Term Code | Max | Max | | Hold | Hold | | Max | Max | | Max | Max | Max |
| 70th %ile Green (s) | 41.5 | 41.5 | | 0.0 | 0.0 | | 13.5 | 39.5 | | 21.5 | 21.5 | 41.5 |
| 70th %ile Term Code | Hold | Max | | Skip | Skip | | Max | Max | | Max | Max | Hold |
| 50th %ile Green (s) | 41.5 | 41.5 | | 0.0 | 0.0 | | 13.5 | 39.5 | | 21.5 | 21.5 | 41.5 |
| 50th %ile Term Code | Hold | Max | | Skip | Skip | | Max | Max | | Max | Max | Hold |
| 30th %ile Green (s) | 41.5 | 41.5 | | 0.0 | 0.0 | | 13.5 | 39.5 | | 21.5 | 21.5 | 41.5 |
| 30th %ile Term Code | Hold | Max | | Skip | Skip | | Max | Max | | Max | Max | Hold |
| 10th %ile Green (s) | 41.5 | 41.5 | | 0.0 | 0.0 | | 13.5 | 39.5 | | 21.5 | 21.5 | 41.5 |
| 10th %ile Term Code | Hold | Max | | Skip | Skip | | Max | Max | | Max | Max | Hold |
| Stops (vph) | 861 | 792 | | | 11 | | 343 | 379 | | | 656 | 47 |
| Fuel Used(gal) | 114 | 95 | | | 0 | | 63 | 77 | | | 19 | 2 |
| CO Emissions (g/hr) | 7950 | 6658 | | | 12 | | 4413 | 5415 | | | 1306 | 128 |
| NOx Emissions (g/hr) | 1547 | 1295 | | | 2 | | 859 | 1054 | | | 254 | 25 |
| VOC Emissions (g/hr) | 1842 | 1543 | | | 3 | | 1023 | 1255 | | | 303 | 30 |
| Dilemma Vehicles (#) | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Queue Length 50th (ft) | ~1224 | ~1133 | | | 5 | | ~546 | ~613 | | | ~273 | 9 |
| Queue Length 95th (ft) | #1581 | #1460 | | | 20 | | #767 | #840 | | | #391 | 88 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 722 | 739 | | | 259 | | 321 | 318 | | | 781 | 1192 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.87 | 1.75 | | | 0.06 | | 1.96 | 2.13 | | | 1.06 | 0.41 |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Natural Cycle: 120
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.13
Intersection Signal Delay: 333.1 Intersection LOS: F
Intersection Capacity Utilization 141.1% ICU Level of Service H
Analysis Period (min) 15
90th %ile Actuated Cycle: 90
70th %ile Actuated Cycle: 90
50th %ile Actuated Cycle: 90
30th %ile Actuated Cycle: 90
10th %ile Actuated Cycle: 90
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1800 | 5 | 625 | 5 | 5 | 5 | 1110 | 85 | 5 | 5 | 755 | 450 |
| Future Volume (vph) | 1800 | 5 | 625 | 5 | 5 | 5 | 1110 | 85 | 5 | 5 | 755 | 450 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 0.95 | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 0.96 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1547 | | | 1700 | | 1633 | 1647 | | | 3437 | 1538 |
| Flt Permitted | 0.65 | 0.78 | | | 0.62 | | 0.15 | 0.14 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1118 | 1241 | | | 1072 | | 264 | 245 | | | 3268 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1957 | 5 | 679 | 5 | 5 | 5 | 1207 | 92 | 5 | 5 | 821 | 489 |
| RTOR Reduction (vph) | 0 | 42 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 159 |
| Lane Group Flow (vph) | 1350 | 1249 | 0 | 0 | 10 | 0 | 628 | 675 | 0 | 0 | 826 | 330 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 45.1 | 45.1 | | | 4.3 | | 39.5 | 39.5 | | | 21.5 | 57.8 |
| Effective Green, g (s) | 45.1 | 45.1 | | | 4.3 | | 39.5 | 39.5 | | | 21.5 | 57.8 |
| Actuated g/C Ratio | 0.48 | 0.48 | | | 0.05 | | 0.42 | 0.42 | | | 0.23 | 0.62 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 738 | 716 | | | 49 | | 308 | 305 | | | 750 | 1023 |
| v/s Ratio Prot | c0.71 | 0.68 | | | | | 0.29 | c0.32 | | | | 0.12 |
| v/s Ratio Perm | c0.17 | 0.16 | | | 0.01 | | 0.56 | c0.61 | | | 0.25 | 0.09 |
| v/c Ratio | 1.83 | 1.74 | | | 0.21 | | 2.04 | 2.21 | | | 1.10 | 0.32 |
| Uniform Delay, d1 | 23.4 | 24.2 | | | 43.0 | | 25.0 | 27.0 | | | 36.0 | 8.5 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 378.5 | 340.5 | | | 2.1 | | 478.7 | 557.1 | | | 64.1 | 0.2 |
| Delay (s) | 401.8 | 364.7 | | | 45.1 | | 503.8 | 584.1 | | | 100.2 | 8.7 |
| Level of Service | F | F | | | D | | F | F | | | F | A |
| Approach Delay (s) | | 383.7 | | | 45.1 | | | 545.4 | | | 66.2 | |
| Approach LOS | | F | | | D | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 343.6 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 2.18 | | |
| Actuated Cycle Length (s) | 93.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 141.1% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

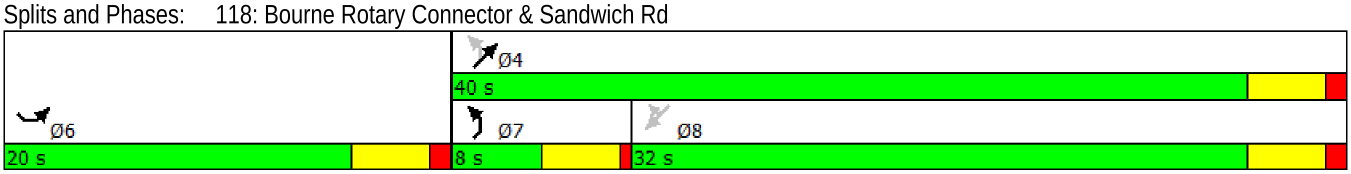
| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 220 | 125 | 25 | 1235 | 320 | 715 |
| Future Volume (vph) | 220 | 125 | 25 | 1235 | 320 | 715 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 1000 | 0 | 0 | | | 425 |
| Storage Lanes | 1 | 0 | 0 | | | 1 |
| Taper Length (ft) | 25 | | 25 | | | |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | 0.946 | | | | | 0.850 |
| Flt Protected | 0.969 | | | 0.999 | | |
| Satd. Flow (prot) | 3218 | 0 | 0 | 3435 | 1810 | 1538 |
| Flt Permitted | 0.969 | | | 0.945 | | |
| Satd. Flow (perm) | 3218 | 0 | 0 | 3249 | 1810 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 136 | | | | | 777 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1745 | | | 824 | 1013 | |
| Travel Time (s) | 39.7 | | | 18.7 | 23.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 239 | 136 | 27 | 1342 | 348 | 777 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 375 | 0 | 0 | 1369 | 348 | 777 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 24 | | | 0 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | 15 | | | 9 |
| Number of Detectors | 1 | | 1 | 2 | 2 | 1 |
| Detector Template | Left | | Left | Thru | Thru | Right |
| Leading Detector (ft) | 20 | | 20 | 100 | 100 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | | 20 | 6 | 6 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | | | 94 | 94 | |
| Detector 2 Size(ft) | | | | 6 | 6 | |
| Detector 2 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Detector Phase | 6 | | 7 | 4 | 8 | 8 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 4.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 8.0 | 20.0 | 22.5 | 22.5 |
| Total Split (s) | 20.0 | | 8.0 | 40.0 | 32.0 | 32.0 |
| Total Split (%) | 33.3% | | 13.3% | 66.7% | 53.3% | 53.3% |
| Maximum Green (s) | 15.5 | | 4.0 | 35.5 | 27.5 | 27.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 0.5 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | Lead | | Lag | Lag |
| Lead-Lag Optimize? | | | Yes | | Yes | Yes |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | None | Min | Min | Min |
| Walk Time (s) | | | | | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | | | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | | | 0 | 0 |
| Act Effct Green (s) | 9.3 | | | 28.5 | 28.5 | 28.5 |
| Actuated g/C Ratio | 0.20 | | | 0.60 | 0.60 | 0.60 |
| v/c Ratio | 0.51 | | | 0.70 | 0.32 | 0.63 |
| Control Delay | 14.2 | | | 8.8 | 5.6 | 3.1 |
| Queue Delay | 0.0 | | | 0.0 | 0.0 | 0.0 |
| Total Delay | 14.2 | | | 8.8 | 5.6 | 3.1 |
| LOS | B | | | A | A | A |
| Approach Delay | 14.2 | | | 8.8 | 3.8 | |
| Approach LOS | B | | | A | A | |
| 90th %ile Green (s) | 13.1 | | 0.0 | 35.5 | 35.5 | 35.5 |
| 90th %ile Term Code | Gap | | Skip | Max | Hold | Hold |
| 70th %ile Green (s) | 10.9 | | 0.0 | 35.5 | 35.5 | 35.5 |
| 70th %ile Term Code | Gap | | Skip | Max | Hold | Hold |
| 50th %ile Green (s) | 9.4 | | 0.0 | 30.6 | 30.6 | 30.6 |
| 50th %ile Term Code | Gap | | Skip | Gap | Hold | Hold |
| 30th %ile Green (s) | 7.6 | | 0.0 | 24.1 | 24.1 | 24.1 |
| 30th %ile Term Code | Gap | | Skip | Gap | Hold | Hold |
| 10th %ile Green (s) | 6.0 | | 0.0 | 18.3 | 18.3 | 18.3 |
| 10th %ile Term Code | Gap | | Skip | Gap | Hold | Hold |
| Stops (vph) | 177 | | | 735 | 130 | 48 |
| Fuel Used(gal) | 7 | | | 14 | 4 | 6 |
| CO Emissions (g/hr) | 466 | | | 1006 | 252 | 444 |
| NOx Emissions (g/hr) | 91 | | | 196 | 49 | 86 |
| VOC Emissions (g/hr) | 108 | | | 233 | 58 | 103 |
| Dilemma Vehicles (#) | 0 | | | 0 | 0 | 0 |
| Queue Length 50th (ft) | 30 | | | 107 | 37 | 0 |
| Queue Length 95th (ft) | 68 | | | 201 | 84 | 33 |
| Internal Link Dist (ft) | 1665 | | | 744 | 933 | |
| Turn Bay Length (ft) | 1000 | | | | | 425 |
| Base Capacity (vph) | 1190 | | | 2504 | 1224 | 1292 |
| Starvation Cap Reductn | 0 | | | 0 | 0 | 0 |

| Lane Group | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | | | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.32 | | | 0.55 | 0.28 | 0.60 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 60 | |
| Actuated Cycle Length: 47.2 | |
| Natural Cycle: 60 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.70 | |
| Intersection Signal Delay: 7.5 | Intersection LOS: A |
| Intersection Capacity Utilization 86.6% | ICU Level of Service E |
| Analysis Period (min) 15 | |
| 90th %ile Actuated Cycle: 57.6 | |
| 70th %ile Actuated Cycle: 55.4 | |
| 50th %ile Actuated Cycle: 49 | |
| 30th %ile Actuated Cycle: 40.7 | |
| 10th %ile Actuated Cycle: 33.3 | |

Splits and Phases: 118: Bourne Rotary Connector & Sandwich Rd



| Movement | SEL | SER | NEL | NET | SWT | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 220 | 125 | 25 | 1235 | 320 | 715 |
| Future Volume (vph) | 220 | 125 | 25 | 1235 | 320 | 715 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Frt | 0.95 | | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.97 | | | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3217 | | | 3435 | 1810 | 1538 |
| Flt Permitted | 0.97 | | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3217 | | | 3250 | 1810 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 239 | 136 | 27 | 1342 | 348 | 777 |
| RTOR Reduction (vph) | 109 | 0 | 0 | 0 | 0 | 304 |
| Lane Group Flow (vph) | 266 | 0 | 0 | 1369 | 348 | 473 |
| Turn Type | Prot | | pm+pt | NA | NA | custom |
| Protected Phases | 6 | | 7 | 4 | | |
| Permitted Phases | | | 4 | | 8 | 8 |
| Actuated Green, G (s) | 9.3 | | | 28.5 | 28.5 | 28.5 |
| Effective Green, g (s) | 9.3 | | | 28.5 | 28.5 | 28.5 |
| Actuated g/C Ratio | 0.20 | | | 0.61 | 0.61 | 0.61 |
| Clearance Time (s) | 4.5 | | | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 639 | | | 1979 | 1102 | 936 |
| v/s Ratio Prot | c0.08 | | | | | |
| v/s Ratio Perm | | | | c0.42 | 0.19 | 0.31 |
| v/c Ratio | 0.42 | | | 0.69 | 0.32 | 0.51 |
| Uniform Delay, d1 | 16.4 | | | 6.2 | 4.4 | 5.2 |
| Progression Factor | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | | | 1.1 | 0.2 | 0.4 |
| Delay (s) | 16.8 | | | 7.2 | 4.6 | 5.6 |
| Level of Service | B | | | A | A | A |
| Approach Delay (s) | 16.8 | | | 7.2 | 5.3 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 7.7 | HCM 2000 Level of Service | A |
| HCM 2000 Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 46.8 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 86.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 65 | 1390 | 65 | 5 | 1020 |
| Future Volume (vph) | 10 | 65 | 1390 | 65 | 5 | 1020 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.883 | | 0.994 | | | |
| Flt Protected | 0.993 | | | | | |
| Satd. Flow (prot) | 1587 | 0 | 1799 | 0 | 0 | 1810 |
| Flt Permitted | 0.993 | | | | | |
| Satd. Flow (perm) | 1587 | 0 | 1799 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 607 | | 3519 | | | 1081 |
| Travel Time (s) | 13.8 | | 80.0 | | | 24.6 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 71 | 1511 | 71 | 5 | 1109 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 82 | 0 | 1582 | 0 | 0 | 1114 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 12 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 88.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 10 | 65 | 1390 | 65 | 5 | 1020 |
| Future Volume (Veh/h) | 10 | 65 | 1390 | 65 | 5 | 1020 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 11 | 71 | 1511 | 71 | 5 | 1109 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2666 | 1546 | | | 1582 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2666 | 1546 | | | 1582 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 54 | 49 | | | 99 | |
| cM capacity (veh/h) | 24 | 138 | | | 407 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 82 | 1582 | 1114 |
| Volume Left | 11 | 0 | 5 |
| Volume Right | 71 | 71 | 0 |
| cSH | 84 | 1700 | 407 |
| Volume to Capacity | 0.97 | 0.93 | 0.01 |
| Queue Length 95th (ft) | 135 | 0 | 1 |
| Control Delay (s) | 178.4 | 0.0 | 0.6 |
| Lane LOS | F | | A |
| Approach Delay (s) | 178.4 | 0.0 | 0.6 |
| Approach LOS | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.5 | | |
| Intersection Capacity Utilization | 88.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 125 | 175 | 20 | 60 | 200 | 55 | 20 | 105 | 240 | 35 | 60 | 100 |
| Future Volume (vph) | 125 | 175 | 20 | 60 | 200 | 55 | 20 | 105 | 240 | 35 | 60 | 100 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Ped Bike Factor | | | | | | | | | | | | |
| Frt | | 0.991 | | | 0.976 | | | 0.911 | | | 0.931 | |
| Flt Protected | | 0.981 | | | 0.991 | | | 0.997 | | | 0.991 | |
| Satd. Flow (prot) | 0 | 1759 | 0 | 0 | 1750 | 0 | 0 | 1644 | 0 | 0 | 1670 | 0 |
| Flt Permitted | | 0.981 | | | 0.991 | | | 0.997 | | | 0.991 | |
| Satd. Flow (perm) | 0 | 1759 | 0 | 0 | 1750 | 0 | 0 | 1644 | 0 | 0 | 1670 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 649 | | | 646 | | | 758 | | | 537 | |
| Travel Time (s) | | 14.8 | | | 14.7 | | | 17.2 | | | 12.2 | |
| Confl. Peds. (#/hr) | | | | | | | | | | 55 | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 136 | 190 | 22 | 65 | 217 | 60 | 22 | 114 | 261 | 38 | 65 | 109 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 348 | 0 | 0 | 342 | 0 | 0 | 397 | 0 | 0 | 212 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 62.3% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | | ✣ | |
| Traffic Volume (veh/h) | 125 | 175 | 20 | 60 | 200 | 55 | 20 | 105 | 240 | 35 | 60 | 100 |
| Future Volume (Veh/h) | 125 | 175 | 20 | 60 | 200 | 55 | 20 | 105 | 240 | 35 | 60 | 100 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 136 | 190 | 22 | 65 | 217 | 60 | 22 | 114 | 261 | 38 | 65 | 109 |
| Pedestrians | | | | | 55 | | | | | | | |
| Lane Width (ft) | | | | | 12.0 | | | | | | | |
| Walking Speed (ft/s) | | | | | 4.0 | | | | | | | |
| Percent Blockage | | | | | 5 | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 277 | | | 212 | | | 992 | 880 | 256 | 1223 | 861 | 247 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 277 | | | 212 | | | 992 | 880 | 256 | 1223 | 861 | 247 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 89 | | | 95 | | | 84 | 53 | 65 | 29 | 74 | 86 |
| cM capacity (veh/h) | 1269 | | | 1341 | | | 135 | 240 | 740 | 53 | 246 | 784 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 348 | 342 | 397 | 212 |
| Volume Left | 136 | 65 | 22 | 38 |
| Volume Right | 22 | 60 | 261 | 109 |
| cSH | 1269 | 1341 | 401 | 190 |
| Volume to Capacity | 0.11 | 0.05 | 0.99 | 1.11 |
| Queue Length 95th (ft) | 9 | 4 | 299 | 260 |
| Control Delay (s) | 3.8 | 1.9 | 75.0 | 150.6 |
| Lane LOS | A | A | F | F |
| Approach Delay (s) | 3.8 | 1.9 | 75.0 | 150.6 |
| Approach LOS | | | F | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 49.0 | | |
| Intersection Capacity Utilization | 62.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 40 | 335 | 0 | 740 | 1730 | 45 | 0 | 0 | 0 | 45 | 60 | 20 |
| Future Volume (vph) | 40 | 335 | 0 | 740 | 1730 | 45 | 0 | 0 | 0 | 45 | 60 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | 0.996 | | | | | | 0.978 | |
| Flt Protected | 0.950 | | | 0.950 | | | | | | | 0.982 | |
| Satd. Flow (prot) | 1719 | 3438 | 0 | 1719 | 3424 | 0 | 0 | 0 | 0 | 0 | 1738 | 0 |
| Flt Permitted | 0.950 | | | 0.950 | | | | | | | 0.982 | |
| Satd. Flow (perm) | 1719 | 3438 | 0 | 1719 | 3424 | 0 | 0 | 0 | 0 | 0 | 1738 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | | | 5 | | | | | | 8 | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 702 | | | 714 | | | 283 | | | 411 | |
| Travel Time (s) | | 16.0 | | | 16.2 | | | 6.4 | | | 9.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 43 | 364 | 0 | 804 | 1880 | 49 | 0 | 0 | 0 | 49 | 65 | 22 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 43 | 364 | 0 | 804 | 1929 | 0 | 0 | 0 | 0 | 0 | 136 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | | | | 1 | 2 | |
| Detector Template | Left | Thru | | Left | Thru | | | | | Left | Thru | |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | | | | 20 | 100 | |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | | | | 0 | 0 | |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | | | | 0 | 0 | |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | | | | 20 | 6 | |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | | | | Cl+Ex | Cl+Ex | |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | | | 0.0 | 0.0 | |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | | | 0.0 | 0.0 | |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | | | 0.0 | 0.0 | |
| Detector 2 Position(ft) | | 94 | | | 94 | | | | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | | | | 0.0 | |
| Turn Type | Prot | NA | | Prot | NA | | | | | Perm | NA | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | | | | 4 | |
| Permitted Phases | | | | | | | | | | 4 | | |
| Detector Phase | 1 | 6 | | 5 | 2 | | | | | 4 | 4 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 4.0 | 10.0 | | 10.0 | 10.0 | | | | | 10.0 | 10.0 | |

# Lanes, Volumes, Timings
## 126: Route 3 EB on-ramp/Church Ln & Scenic Hwy

02/16/2018

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Split (s) | 11.0 | 17.0 | | 17.0 | 17.0 | | | | | 17.0 | 17.0 | |
| Total Split (s) | 15.0 | 24.0 | | 59.0 | 68.0 | | | | | 17.0 | 17.0 | |
| Total Split (%) | 15.0% | 24.0% | | 59.0% | 68.0% | | | | | 17.0% | 17.0% | |
| Maximum Green (s) | 8.0 | 17.0 | | 52.0 | 61.0 | | | | | 10.0 | 10.0 | |
| Yellow Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | | | | 4.0 | 4.0 | |
| All-Red Time (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | | | | 3.0 | 3.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | | | | | 0.0 | |
| Total Lost Time (s) | 7.0 | 7.0 | | 7.0 | 7.0 | | | | | | 7.0 | |
| Lead/Lag | Lead | Lag | | Lead | Lag | | | | | | | |
| Lead-Lag Optimize? | Yes | Yes | | Yes | Yes | | | | | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | | | | 2.0 | 2.0 | |
| Recall Mode | None | C-Max | | None | C-Max | | | | | None | None | |
| Act Effct Green (s) | 6.6 | 19.1 | | 49.9 | 67.2 | | | | | | 10.0 | |
| Actuated g/C Ratio | 0.07 | 0.19 | | 0.50 | 0.67 | | | | | | 0.10 | |
| v/c Ratio | 0.38 | 0.55 | | 0.94 | 0.84 | | | | | | 0.75 | |
| Control Delay | 53.9 | 41.1 | | 43.3 | 18.5 | | | | | | 67.2 | |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | | | | | 0.0 | |
| Total Delay | 53.9 | 41.1 | | 43.3 | 18.5 | | | | | | 67.2 | |
| LOS | D | D | | D | B | | | | | | E | |
| Approach Delay | | 42.4 | | | 25.8 | | | | | | 67.2 | |
| Approach LOS | | D | | | C | | | | | | E | |
| 90th %ile Green (s) | 8.0 | 17.0 | | 52.0 | 61.0 | | | | | 10.0 | 10.0 | |
| 90th %ile Term Code | Max | Coord | | Max | Coord | | | | | Max | Max | |
| 70th %ile Green (s) | 8.0 | 17.0 | | 52.0 | 61.0 | | | | | 10.0 | 10.0 | |
| 70th %ile Term Code | Max | Coord | | Max | Coord | | | | | Max | Max | |
| 50th %ile Green (s) | 6.9 | 17.0 | | 52.0 | 62.1 | | | | | 10.0 | 10.0 | |
| 50th %ile Term Code | Gap | Coord | | Max | Coord | | | | | Max | Max | |
| 30th %ile Green (s) | 0.0 | 19.1 | | 49.9 | 76.0 | | | | | 10.0 | 10.0 | |
| 30th %ile Term Code | Skip | Coord | | Gap | Coord | | | | | Max | Max | |
| 10th %ile Green (s) | 0.0 | 25.5 | | 43.5 | 76.0 | | | | | 10.0 | 10.0 | |
| 10th %ile Term Code | Skip | Coord | | Gap | Coord | | | | | Max | Max | |
| Stops (vph) | 39 | 298 | | 634 | 1248 | | | | | | 107 | |
| Fuel Used(gal) | 1 | 6 | | 14 | 23 | | | | | | 3 | |
| CO Emissions (g/hr) | 61 | 439 | | 988 | 1640 | | | | | | 189 | |
| NOx Emissions (g/hr) | 12 | 85 | | 192 | 319 | | | | | | 37 | |
| VOC Emissions (g/hr) | 14 | 102 | | 229 | 380 | | | | | | 44 | |
| Dilemma Vehicles (#) | 0 | 0 | | 0 | 0 | | | | | | 0 | |
| Queue Length 50th (ft) | 27 | 114 | | 441 | 514 | | | | | | 81 | |
| Queue Length 95th (ft) | 61 | 163 | | #706 | #710 | | | | | | #177 | |
| Internal Link Dist (ft) | | 622 | | | 634 | | | 203 | | | 331 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 137 | 657 | | 893 | 2303 | | | | | | 181 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | | | | | 0 | |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | | | | | 0 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | | | | | 0 | |
| Reduced v/c Ratio | 0.31 | 0.55 | | 0.90 | 0.84 | | | | | | 0.75 | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 100 | |

Actuated Cycle Length: 100
Offset: 75 (75%), Referenced to phase 2:WBT and 6:EBT, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 29.6 Intersection LOS: C
Intersection Capacity Utilization 78.4% ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 126: Route 3 EB on-ramp/Church Ln & Scenic Hwy

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 40 | 335 | 0 | 740 | 1730 | 45 | 0 | 0 | 0 | 45 | 60 | 20 |
| Future Volume (vph) | 40 | 335 | 0 | 740 | 1730 | 45 | 0 | 0 | 0 | 45 | 60 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 7.0 | 7.0 | | 7.0 | 7.0 | | | | | | 7.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | | | | | | 1.00 | |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | | | | | | 0.98 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | | | | | 0.98 | |
| Satd. Flow (prot) | 1719 | 3438 | | 1719 | 3425 | | | | | | 1739 | |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | | | | | | 0.98 | |
| Satd. Flow (perm) | 1719 | 3438 | | 1719 | 3425 | | | | | | 1739 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 43 | 364 | 0 | 804 | 1880 | 49 | 0 | 0 | 0 | 49 | 65 | 22 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Lane Group Flow (vph) | 43 | 364 | 0 | 804 | 1927 | 0 | 0 | 0 | 0 | 0 | 129 | 0 |
| Turn Type | Prot | NA | | Prot | NA | | | | | Perm | NA | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | | | | 4 | |
| Permitted Phases | | | | | | | | | | 4 | | |
| Actuated Green, G (s) | 4.6 | 19.1 | | 49.9 | 64.4 | | | | | | 10.0 | |
| Effective Green, g (s) | 4.6 | 19.1 | | 49.9 | 64.4 | | | | | | 10.0 | |
| Actuated g/C Ratio | 0.05 | 0.19 | | 0.50 | 0.64 | | | | | | 0.10 | |
| Clearance Time (s) | 7.0 | 7.0 | | 7.0 | 7.0 | | | | | | 7.0 | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | | | | | 2.0 | |
| Lane Grp Cap (vph) | 79 | 656 | | 857 | 2205 | | | | | | 173 | |
| v/s Ratio Prot | 0.03 | 0.11 | | c0.47 | c0.56 | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.07 | |
| v/c Ratio | 0.54 | 0.55 | | 0.94 | 0.87 | | | | | | 0.74 | |
| Uniform Delay, d1 | 46.7 | 36.6 | | 23.6 | 14.5 | | | | | | 43.8 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | | | | | 1.00 | |
| Incremental Delay, d2 | 4.1 | 3.4 | | 17.2 | 5.2 | | | | | | 14.0 | |
| Delay (s) | 50.7 | 40.0 | | 40.8 | 19.7 | | | | | | 57.8 | |
| Level of Service | D | D | | D | B | | | | | | E | |
| Approach Delay (s) | | 41.1 | | | 25.9 | | | 0.0 | | | 57.8 | |
| Approach LOS | | D | | | C | | | A | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 29.1 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 100.0 | Sum of lost time (s) | 21.0 |
| Intersection Capacity Utilization | 78.4% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 320 | 10 | 600 | 140 | 25 | 25 |
| Future Volume (vph) | 320 | 10 | 600 | 140 | 25 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.996 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1802 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.222 | | 0.950 | |
| Satd. Flow (perm) | 1802 | 0 | 402 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 2 | | | | | 27 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 612 | | | 1745 | 701 | |
| Travel Time (s) | 13.9 | | | 39.7 | 15.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 348 | 11 | 652 | 152 | 27 | 27 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 359 | 0 | 652 | 152 | 27 | 27 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 21.0 | | 32.0 | 53.0 | 22.0 | 22.0 |
| Total Split (%) | 28.0% | | 42.7% | 70.7% | 29.3% | 29.3% |
| Maximum Green (s) | 16.5 | | 27.5 | 48.5 | 17.5 | 17.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 19.0 | | 53.2 | 53.2 | 12.8 | 12.8 |
| Actuated g/C Ratio | 0.25 | | 0.71 | 0.71 | 0.17 | 0.17 |
| v/c Ratio | 0.79 | | 0.81 | 0.12 | 0.09 | 0.10 |
| Control Delay | 40.8 | | 19.3 | 3.0 | 30.8 | 13.6 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 40.8 | | 19.3 | 3.0 | 30.8 | 13.6 |
| LOS | D | | B | A | C | B |
| Approach Delay | 40.8 | | | 16.2 | 22.2 | |
| Approach LOS | D | | | B | C | |
| 90th %ile Green (s) | 16.5 | | 36.5 | 57.5 | 8.5 | 8.5 |
| 90th %ile Term Code | Max | | Max | Hold | Coord | Coord |
| 70th %ile Green (s) | 21.8 | | 32.3 | 58.6 | 7.4 | 7.4 |
| 70th %ile Term Code | Max | | Gap | Hold | Coord | Coord |
| 50th %ile Green (s) | 21.6 | | 29.4 | 55.5 | 10.5 | 10.5 |
| 50th %ile Term Code | Gap | | Gap | Hold | Coord | Coord |
| 30th %ile Green (s) | 19.4 | | 27.5 | 51.4 | 14.6 | 14.6 |
| 30th %ile Term Code | Gap | | Gap | Hold | Coord | Coord |
| 10th %ile Green (s) | 15.5 | | 23.1 | 43.1 | 22.9 | 22.9 |
| 10th %ile Term Code | Gap | | Gap | Hold | Coord | Coord |
| Stops (vph) | 270 | | 367 | 33 | 25 | 10 |
| Fuel Used(gal) | 6 | | 13 | 2 | 0 | 0 |
| CO Emissions (g/hr) | 406 | | 877 | 152 | 30 | 18 |
| NOx Emissions (g/hr) | 79 | | 171 | 30 | 6 | 4 |
| VOC Emissions (g/hr) | 94 | | 203 | 35 | 7 | 4 |
| Dilemma Vehicles (#) | 0 | | 0 | 0 | 0 | 0 |
| Queue Length 50th (ft) | 147 | | 172 | 16 | 11 | 0 |
| Queue Length 95th (ft) | #317 | | 263 | 25 | 34 | 22 |
| Internal Link Dist (ft) | 532 | | | 1665 | 621 | |
| Turn Bay Length (ft) | | | 500 | | | |
| Base Capacity (vph) | 462 | | 823 | 1310 | 426 | 401 |
| Starvation Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.78 | | 0.79 | 0.12 | 0.06 | 0.07 |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 75 | |
| Actuated Cycle Length: 75 | |
| Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green | |
| Natural Cycle: 75 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.81 | |
| Intersection Signal Delay: 23.7 | Intersection LOS: C |
| Intersection Capacity Utilization 66.1% | ICU Level of Service C |
| Analysis Period (min) 15 | |
| # 95th percentile volume exceeds capacity, queue may be longer. | |
| Queue shown is maximum after two cycles. | |

Splits and Phases: 133: Veteran's Way & Old Sandwich Road

# HCM Signalized Intersection Capacity Analysis
## 133: Veteran's Way & Old Sandwich Road

02/16/2018

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 320 | 10 | 600 | 140 | 25 | 25 |
| Future Volume (vph) | 320 | 10 | 600 | 140 | 25 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1802 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.22 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1802 | | 402 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 348 | 11 | 652 | 152 | 27 | 27 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 22 |
| Lane Group Flow (vph) | 358 | 0 | 652 | 152 | 27 | 5 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 19.0 | | 53.3 | 53.3 | 12.7 | 12.7 |
| Effective Green, g (s) | 19.0 | | 53.3 | 53.3 | 12.7 | 12.7 |
| Actuated g/C Ratio | 0.25 | | 0.71 | 0.71 | 0.17 | 0.17 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 456 | | 808 | 1286 | 291 | 260 |
| v/s Ratio Prot | 0.20 | | c0.32 | 0.08 | c0.02 | |
| v/s Ratio Perm | | | c0.25 | | | 0.00 |
| v/c Ratio | 0.78 | | 0.81 | 0.12 | 0.09 | 0.02 |
| Uniform Delay, d1 | 26.1 | | 12.3 | 3.4 | 26.3 | 26.0 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 8.6 | | 5.9 | 0.0 | 0.6 | 0.1 |
| Delay (s) | 34.7 | | 18.3 | 3.5 | 26.9 | 26.1 |
| Level of Service | C | | B | A | C | C |
| Approach Delay (s) | 34.7 | | | 15.5 | 26.5 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 66.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 130 | 380 | 830 | 20 | 5 | 305 |
| Future Volume (vph) | 130 | 380 | 830 | 20 | 5 | 305 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 | 1.00 |
| Frt | | | 0.996 | | 0.867 | |
| Flt Protected | | 0.987 | | | 0.999 | |
| Satd. Flow (prot) | 0 | 3393 | 3424 | 0 | 1567 | 0 |
| Flt Permitted | | 0.987 | | | 0.999 | |
| Satd. Flow (perm) | 0 | 3393 | 3424 | 0 | 1567 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 163 | 645 | | 352 | |
| Travel Time (s) | | 3.7 | 14.7 | | 8.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 141 | 413 | 902 | 22 | 5 | 332 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 554 | 924 | 0 | 337 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 67.0% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 130 | 380 | 830 | 20 | 5 | 305 |
| Future Volume (Veh/h) | 130 | 380 | 830 | 20 | 5 | 305 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 141 | 413 | 902 | 22 | 5 | 332 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 924 | | | | 1402 | 462 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 924 | | | | 1402 | 462 |
| tC, single (s) | 4.2 | | | | 6.9 | 7.0 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 80 | | | | 95 | 38 |
| cM capacity (veh/h) | 717 | | | | 102 | 538 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | SW 1 |
|---|---|---|---|---|---|
| Volume Total | 279 | 275 | 601 | 323 | 337 |
| Volume Left | 141 | 0 | 0 | 0 | 5 |
| Volume Right | 0 | 0 | 0 | 22 | 332 |
| cSH | 717 | 1700 | 1700 | 1700 | 506 |
| Volume to Capacity | 0.20 | 0.16 | 0.35 | 0.19 | 0.67 |
| Queue Length 95th (ft) | 18 | 0 | 0 | 0 | 121 |
| Control Delay (s) | 6.9 | 0.0 | 0.0 | 0.0 | 25.1 |
| Lane LOS | A | | | | D |
| Approach Delay (s) | 3.5 | | 0.0 | | 25.1 |
| Approach LOS | | | | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.7 | | |
| Intersection Capacity Utilization | 67.0% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Lane Group | EBT | EBR | WBL | WBT | NEL | NER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 85 | 30 | 65 | 130 | 35 | 75 |
| Future Volume (vph) | 85 | 30 | 65 | 130 | 35 | 75 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.964 | | | | 0.908 | |
| Flt Protected | | | | 0.984 | 0.984 | |
| Satd. Flow (prot) | 1744 | 0 | 0 | 1781 | 1617 | 0 |
| Flt Permitted | | | | 0.984 | 0.984 | |
| Satd. Flow (perm) | 1744 | 0 | 0 | 1781 | 1617 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1094 | | | 1029 | 1588 | |
| Travel Time (s) | 24.9 | | | 23.4 | 36.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 33 | 71 | 141 | 38 | 82 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 125 | 0 | 0 | 212 | 120 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 30.3% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NEL | NER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 85 | 30 | 65 | 130 | 35 | 75 |
| Future Volume (Veh/h) | 85 | 30 | 65 | 130 | 35 | 75 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 92 | 33 | 71 | 141 | 38 | 82 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 125 | | 392 | 108 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 125 | | 392 | 108 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 95 | | 93 | 91 |
| cM capacity (veh/h) | | | 1443 | | 577 | 937 |

| Direction, Lane # | EB 1 | WB 1 | NE 1 |
|---|---|---|---|
| Volume Total | 125 | 212 | 120 |
| Volume Left | 0 | 71 | 38 |
| Volume Right | 33 | 0 | 82 |
| cSH | 1700 | 1443 | 782 |
| Volume to Capacity | 0.07 | 0.05 | 0.15 |
| Queue Length 95th (ft) | 0 | 4 | 13 |
| Control Delay (s) | 0.0 | 2.8 | 10.4 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 2.8 | 10.4 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.0 | | |
| Intersection Capacity Utilization | 30.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 25 | 0 | 135 | 0 | 5 | 10 | 0 | 565 | 45 | 140 | 1070 | 0 |
| Future Volume (vph) | 25 | 0 | 135 | 0 | 5 | 10 | 0 | 565 | 45 | 140 | 1070 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.886 | | | 0.907 | | | 0.990 | | | | |
| Flt Protected | | 0.992 | | | | | | | | | 0.994 | |
| Satd. Flow (prot) | 0 | 1590 | 0 | 0 | 1641 | 0 | 0 | 1791 | 0 | 0 | 1799 | 0 |
| Flt Permitted | | 0.992 | | | | | | | | | 0.994 | |
| Satd. Flow (perm) | 0 | 1590 | 0 | 0 | 1641 | 0 | 0 | 1791 | 0 | 0 | 1799 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 1029 | | | 573 | | | 1000 | | | 878 | |
| Travel Time (s) | | 23.4 | | | 13.0 | | | 22.7 | | | 20.0 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 27 | 0 | 147 | 0 | 5 | 11 | 0 | 614 | 49 | 152 | 1163 | 0 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 174 | 0 | 0 | 16 | 0 | 0 | 663 | 0 | 0 | 1315 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 122.9% ICU Level of Service H

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
147: Old Kings Hwy 6A & Main St/Old Main St 02/16/2018

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | | ✣ | |
| Traffic Volume (veh/h) | 25 | 0 | 135 | 0 | 5 | 10 | 0 | 565 | 45 | 140 | 1070 | 0 |
| Future Volume (Veh/h) | 25 | 0 | 135 | 0 | 5 | 10 | 0 | 565 | 45 | 140 | 1070 | 0 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 27 | 0 | 147 | 0 | 5 | 11 | 0 | 614 | 49 | 152 | 1163 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 2119 | 2106 | 638 | 2106 | 2081 | 1163 | 1163 | | | 614 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 2119 | 2106 | 638 | 2106 | 2081 | 1163 | 1163 | | | 614 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 2 | 100 | 69 | 100 | 89 | 95 | 100 | | | 84 | | |
| cM capacity (veh/h) | 28 | 42 | 471 | 22 | 44 | 234 | 590 | | | 951 | | |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | NW 1 |
|---|---|---|---|---|
| Volume Total | 174 | 16 | 663 | 1315 |
| Volume Left | 27 | 0 | 0 | 152 |
| Volume Right | 147 | 11 | 49 | 0 |
| cSH | 135 | 99 | 590 | 951 |
| Volume to Capacity | 1.29 | 0.16 | 0.00 | 0.16 |
| Queue Length 95th (ft) | 273 | 14 | 0 | 14 |
| Control Delay (s) | 239.0 | 48.0 | 0.0 | 5.4 |
| Lane LOS | F | E | | A |
| Approach Delay (s) | 239.0 | 48.0 | 0.0 | 5.4 |
| Approach LOS | F | E | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 22.8 | | |
| Intersection Capacity Utilization | 122.9% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 25 | 430 | 220 | 70 | 590 | 15 |
| Future Volume (vph) | 25 | 430 | 220 | 70 | 590 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.967 | | 0.997 | |
| Flt Protected | | 0.997 | | | 0.953 | |
| Satd. Flow (prot) | 0 | 1804 | 1750 | 0 | 1719 | 0 |
| Flt Permitted | | 0.997 | | | 0.953 | |
| Satd. Flow (perm) | 0 | 1804 | 1750 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 27 | 467 | 239 | 76 | 641 | 16 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 494 | 315 | 0 | 657 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 83.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 25 | 430 | 220 | 70 | 590 | 15 |
| Future Volume (Veh/h) | 25 | 430 | 220 | 70 | 590 | 15 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 27 | 467 | 239 | 76 | 641 | 16 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 315 | | | | 798 | 277 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 315 | | | | 798 | 277 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 98 | | | | 0 | 98 |
| cM capacity (veh/h) | 1228 | | | | 343 | 755 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 494 | 315 | 657 |
| Volume Left | 27 | 0 | 641 |
| Volume Right | 0 | 76 | 16 |
| cSH | 1228 | 1700 | 348 |
| Volume to Capacity | 0.02 | 0.19 | 1.89 |
| Queue Length 95th (ft) | 2 | 0 | 1105 |
| Control Delay (s) | 0.7 | 0.0 | 436.1 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.7 | 0.0 | 436.1 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 195.7 | | |
| Intersection Capacity Utilization | 83.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Future Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 83.3% ICU Level of Service E

Analysis Period (min) 15

Intersection Sign configuration not allowed in HCM analysis.

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1805 | 5 | 585 | 5 | 5 | 5 | 1015 | 100 | 5 | 5 | 775 | 450 |
| Future Volume (vph) | 1805 | 5 | 585 | 5 | 5 | 5 | 1015 | 100 | 5 | 5 | 775 | 450 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 150 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 1 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.925 | | | 0.955 | | | 0.999 | | | | 0.850 |
| Flt Protected | 0.950 | 0.976 | | | 0.984 | | 0.950 | 0.961 | | | | |
| Satd. Flow (prot) | 1633 | 1552 | 0 | 0 | 1700 | 0 | 1633 | 1650 | 0 | 0 | 3438 | 1538 |
| Flt Permitted | 0.650 | 0.775 | | | 0.620 | | 0.167 | 0.152 | | | 0.951 | |
| Satd. Flow (perm) | 1117 | 1232 | 0 | 0 | 1071 | 0 | 287 | 261 | 0 | 0 | 3270 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 79 | | | 5 | | | 1 | | | | 415 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 333 | | | 284 | | | 282 | | | 370 | |
| Travel Time (s) | | 7.6 | | | 6.5 | | | 6.4 | | | 8.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1962 | 5 | 636 | 5 | 5 | 5 | 1103 | 109 | 5 | 5 | 842 | 489 |
| Shared Lane Traffic (%) | 32% | | | | | | 47% | | | | | |
| Lane Group Flow (vph) | 1334 | 1269 | 0 | 0 | 15 | 0 | 585 | 632 | 0 | 0 | 847 | 489 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

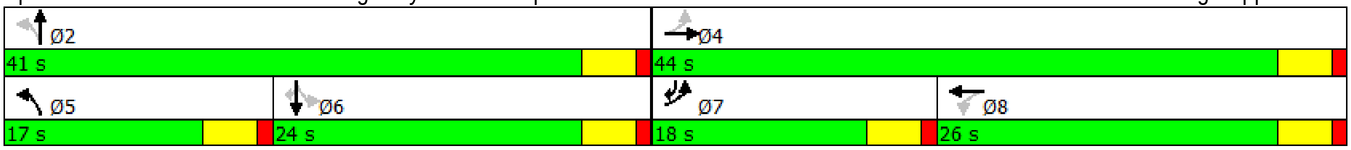
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 18.0 | 44.0 | | 26.0 | 26.0 | | 17.0 | 41.0 | | 24.0 | 24.0 | 18.0 |
| Total Split (%) | 21.2% | 51.8% | | 30.6% | 30.6% | | 20.0% | 48.2% | | 28.2% | 28.2% | 21.2% |
| Maximum Green (s) | 13.5 | 39.5 | | 21.5 | 21.5 | | 12.5 | 36.5 | | 19.5 | 19.5 | 13.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 39.5 | 39.5 | | | 9.2 | | 36.5 | 36.5 | | | 19.5 | 58.3 |
| Actuated g/C Ratio | 0.46 | 0.46 | | | 0.11 | | 0.43 | 0.43 | | | 0.23 | 0.69 |
| v/c Ratio | 1.83 | 1.71 | | | 0.12 | | 1.82 | 2.00 | | | 1.13 | 0.41 |
| Control Delay | 403.1 | 345.4 | | | 26.5 | | 402.8 | 481.3 | | | 106.9 | 3.2 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 403.1 | 345.4 | | | 26.5 | | 402.8 | 481.3 | | | 106.9 | 3.2 |
| LOS | F | F | | | C | | F | F | | | F | A |
| Approach Delay | | 374.9 | | | 26.5 | | | 443.6 | | | 68.9 | |
| Approach LOS | | F | | | C | | | F | | | E | |
| Queue Length 50th (ft) | ~1131 | ~1040 | | | 5 | | ~460 | ~524 | | | ~279 | 8 |
| Queue Length 95th (ft) | #1484 | #1363 | | | 19 | | #672 | #741 | | | #395 | 90 |
| Internal Link Dist (ft) | | 253 | | | 204 | | | 202 | | | 290 | |
| Turn Bay Length (ft) | | | | | | | | | | | | 100 |
| Base Capacity (vph) | 727 | 743 | | | 274 | | 321 | 316 | | | 750 | 1184 |
| Starvation Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | | 0 | | 0 | 0 | | | 0 | 0 |
| Reduced v/c Ratio | 1.83 | 1.71 | | | 0.05 | | 1.82 | 2.00 | | | 1.13 | 0.41 |

Intersection Summary

Area Type: Other
Cycle Length: 85
Actuated Cycle Length: 85
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.00
Intersection Signal Delay: 311.0 Intersection LOS: F
Intersection Capacity Utilization 138.4% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 117: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 1805 | 5 | 585 | 5 | 5 | 5 | 1015 | 100 | 5 | 5 | 775 | 450 |
| Future Volume (vph) | 1805 | 5 | 585 | 5 | 5 | 5 | 1015 | 100 | 5 | 5 | 775 | 450 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | 0.95 | | | 1.00 | | 0.95 | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.92 | | | 0.95 | | 1.00 | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 0.98 | | | 0.98 | | 0.95 | 0.96 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1633 | 1551 | | | 1700 | | 1633 | 1649 | | | 3437 | 1538 |
| Flt Permitted | 0.65 | 0.78 | | | 0.62 | | 0.17 | 0.15 | | | 0.95 | 1.00 |
| Satd. Flow (perm) | 1118 | 1233 | | | 1072 | | 287 | 260 | | | 3269 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1962 | 5 | 636 | 5 | 5 | 5 | 1103 | 109 | 5 | 5 | 842 | 489 |
| RTOR Reduction (vph) | 0 | 41 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 163 |
| Lane Group Flow (vph) | 1334 | 1228 | 0 | 0 | 10 | 0 | 585 | 631 | 0 | 0 | 847 | 326 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 43.1 | 43.1 | | | 4.3 | | 36.5 | 36.5 | | | 19.5 | 53.8 |
| Effective Green, g (s) | 43.1 | 43.1 | | | 4.3 | | 36.5 | 36.5 | | | 19.5 | 53.8 |
| Actuated g/C Ratio | 0.49 | 0.49 | | | 0.05 | | 0.41 | 0.41 | | | 0.22 | 0.61 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | 4.5 | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | 3.0 | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 743 | 722 | | | 52 | | 308 | 303 | | | 719 | 1012 |
| v/s Ratio Prot | c0.69 | 0.66 | | | | | 0.27 | c0.29 | | | | 0.12 |
| v/s Ratio Perm | c0.18 | 0.17 | | | 0.01 | | 0.52 | c0.56 | | | 0.26 | 0.09 |
| v/c Ratio | 1.80 | 1.70 | | | 0.20 | | 1.90 | 2.08 | | | 1.18 | 0.32 |
| Uniform Delay, d1 | 21.9 | 22.7 | | | 40.5 | | 22.8 | 26.0 | | | 34.5 | 8.5 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 363.3 | 321.6 | | | 1.9 | | 416.7 | 498.9 | | | 94.2 | 0.2 |
| Delay (s) | 385.2 | 344.3 | | | 42.3 | | 439.5 | 525.0 | | | 128.7 | 8.7 |
| Level of Service | F | F | | | D | | F | F | | | F | A |
| Approach Delay (s) | | 365.3 | | | 42.3 | | | 483.9 | | | 84.8 | |
| Approach LOS | | F | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 319.8 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 2.11 | | |
| Actuated Cycle Length (s) | 88.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 138.4% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 45 | 410 | 190 | 80 | 650 | 15 |
| Future Volume (vph) | 45 | 410 | 190 | 80 | 650 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.960 | | 0.997 | |
| Flt Protected | | 0.995 | | | 0.953 | |
| Satd. Flow (prot) | 0 | 1800 | 1737 | 0 | 1719 | 0 |
| Flt Permitted | | 0.995 | | | 0.953 | |
| Satd. Flow (perm) | 0 | 1800 | 1737 | 0 | 1719 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 510 | 234 | | 330 | |
| Travel Time (s) | | 11.6 | 5.3 | | 7.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 49 | 446 | 207 | 87 | 707 | 16 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 495 | 294 | 0 | 723 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 85.9% | ICU Level of Service E |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 45 | 410 | 190 | 80 | 650 | 15 |
| Future Volume (Veh/h) | 45 | 410 | 190 | 80 | 650 | 15 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 49 | 446 | 207 | 87 | 707 | 16 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 294 | | | | 794 | 250 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 294 | | | | 794 | 250 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 96 | | | | 0 | 98 |
| cM capacity (veh/h) | 1251 | | | | 339 | 781 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 495 | 294 | 723 |
| Volume Left | 49 | 0 | 707 |
| Volume Right | 0 | 87 | 16 |
| cSH | 1251 | 1700 | 343 |
| Volume to Capacity | 0.04 | 0.17 | 2.11 |
| Queue Length 95th (ft) | 3 | 0 | 1316 |
| Control Delay (s) | 1.2 | 0.0 | 532.9 |
| Lane LOS | A | | F |
| Approach Delay (s) | 1.2 | 0.0 | 532.9 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 255.2 | | |
| Intersection Capacity Utilization | 85.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Lane Group | WBL | WBR | NET | NER | SWL | SWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Future Volume (vph) | 0 | 0 | 1520 | 0 | 0 | 1385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | | | |
| Flt Protected | | | | | | |
| Satd. Flow (prot) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Flt Permitted | | | | | | |
| Satd. Flow (perm) | 0 | 1810 | 1810 | 0 | 0 | 1810 |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 474 | | 550 | | | 219 |
| Travel Time (s) | 10.8 | | 12.5 | | | 5.0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 1652 | 0 | 0 | 1505 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Right | Left | Left |
| Median Width(ft) | 0 | | 0 | | | 0 |
| Link Offset(ft) | 0 | | 0 | | | 0 |
| Crosswalk Width(ft) | 16 | | 16 | | | 16 |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | 9 | | 9 | 15 | |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 83.3% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Intersection Sign configuration not allowed in HCM analysis.

# Previous Screening Analysis

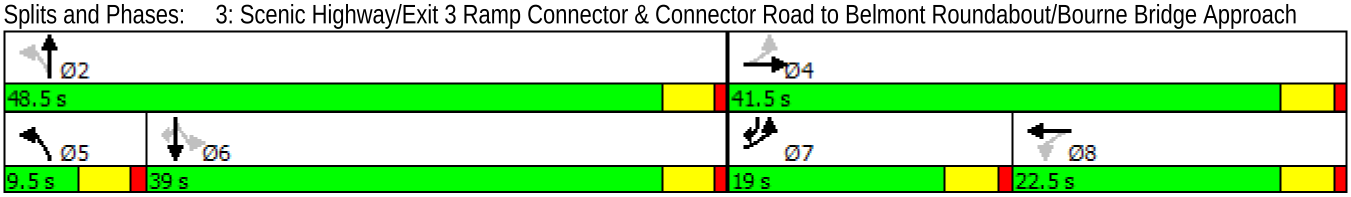
# Belmont Circle

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.998 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.989 | | | 0.999 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3393 | 0 | 0 | 3435 | 1538 |
| Flt Permitted | 0.669 | | | | 0.645 | | | 0.663 | | | 0.925 | |
| Satd. Flow (perm) | 1211 | 1542 | 0 | 0 | 1115 | 0 | 0 | 2275 | 0 | 0 | 3180 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 355 | | | 11 | | | 2 | | | | 668 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 516 | 669 | 0 | 0 | 33 | 0 | 0 | 1011 | 0 | 0 | 446 | 668 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 19.0 | 41.5 | | 22.5 | 22.5 | | 9.5 | 48.5 | | 39.0 | 39.0 | 19.0 |
| Total Split (%) | 21.1% | 46.1% | | 25.0% | 25.0% | | 10.6% | 53.9% | | 43.3% | 43.3% | 21.1% |
| Maximum Green (s) | 14.5 | 37.0 | | 18.0 | 18.0 | | 5.0 | 44.0 | | 34.5 | 34.5 | 14.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 26.8 | 26.8 | | | 10.7 | | | 37.0 | | | 26.8 | 48.6 |
| Actuated g/C Ratio | 0.36 | 0.36 | | | 0.15 | | | 0.50 | | | 0.36 | 0.66 |
| v/c Ratio | 0.92 | 0.85 | | | 0.19 | | | 0.82 | | | 0.38 | 0.54 |
| Control Delay | 47.9 | 22.1 | | | 25.7 | | | 22.9 | | | 18.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 47.9 | 22.1 | | | 25.7 | | | 22.9 | | | 18.8 | 2.5 |
| LOS | D | C | | | C | | | C | | | B | A |
| Approach Delay | | 33.3 | | | 25.7 | | | 22.9 | | | 9.0 | |
| Approach LOS | | C | | | C | | | C | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 90 | |
| Actuated Cycle Length: 73.5 | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.92 | |
| Intersection Signal Delay: 22.0 | Intersection LOS: C |
| Intersection Capacity Utilization 86.6% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 516 | 669 | 33 | 1011 | 446 | 668 |
| v/c Ratio | 0.92 | 0.85 | 0.19 | 0.82 | 0.38 | 0.54 |
| Control Delay | 47.9 | 22.1 | 25.7 | 22.9 | 18.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 47.9 | 22.1 | 25.7 | 22.9 | 18.8 | 2.5 |
| Queue Length 50th (ft) | ~242 | 155 | 10 | 165 | 77 | 0 |
| Queue Length 95th (ft) | #463 | #322 | 36 | #290 | 133 | 42 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 558 | 996 | 301 | 1544 | 1602 | 1243 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.92 | 0.67 | 0.11 | 0.65 | 0.28 | 0.54 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

## HCM Signalized Intersection Capacity Analysis
3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge A 01/17/2017

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.99 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1543 | | | 1700 | | | 3394 | | | 3434 | 1538 |
| Flt Permitted | 0.67 | 1.00 | | | 0.65 | | | 0.66 | | | 0.93 | 1.00 |
| Satd. Flow (perm) | 1210 | 1543 | | | 1115 | | | 2277 | | | 3181 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| RTOR Reduction (vph) | 0 | 218 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 275 |
| Lane Group Flow (vph) | 516 | 451 | 0 | 0 | 23 | 0 | 0 | 1010 | 0 | 0 | 446 | 393 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 29.0 | 29.0 | | | 7.5 | | | 37.0 | | | 27.1 | 44.1 |
| Effective Green, g (s) | 29.0 | 29.0 | | | 7.5 | | | 37.0 | | | 27.1 | 44.1 |
| Actuated g/C Ratio | 0.39 | 0.39 | | | 0.10 | | | 0.49 | | | 0.36 | 0.59 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 583 | 596 | | | 111 | | | 1203 | | | 1149 | 996 |
| v/s Ratio Prot | c0.20 | 0.29 | | | | | | c0.06 | | | | 0.09 |
| v/s Ratio Perm | c0.14 | | | | 0.02 | | | c0.35 | | | 0.14 | 0.17 |
| v/c Ratio | 0.89 | 0.76 | | | 0.21 | | | 0.84 | | | 0.39 | 0.39 |
| Uniform Delay, d1 | 20.8 | 19.9 | | | 31.0 | | | 16.4 | | | 17.8 | 8.3 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 14.9 | 5.5 | | | 0.9 | | | 5.3 | | | 0.2 | 0.3 |
| Delay (s) | 35.8 | 25.4 | | | 32.0 | | | 21.7 | | | 18.0 | 8.5 |
| Level of Service | D | C | | | C | | | C | | | B | A |
| Approach Delay (s) | | 29.9 | | | 32.0 | | | 21.7 | | | 12.3 | |
| Approach LOS | | C | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.98 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 86.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 516 | 11 | 0 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 537 | 531 | 0 | 84 | 22 | 21 | 84 | 967 | 15 | 68 | 1930 | 1200 |
| Arrive On Green | 0.19 | 0.29 | 0.00 | 0.04 | 0.04 | 0.04 | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 492 | 544 | 518 | 3 | 1649 | 26 | 31 | 3290 | 1538 |
| Grp Volume(v), veh/h | 516 | 11 | 0 | 33 | 0 | 0 | 315 | 0 | 696 | 236 | 210 | 668 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1554 | 0 | 0 | 35 | 0 | 1642 | 1757 | 1564 | 1538 |
| Q Serve(g_s), s | 14.5 | 0.3 | 0.0 | 1.4 | 0.0 | 0.0 | 73.3 | 0.0 | 22.8 | 0.0 | 4.8 | 12.7 |
| Cycle Q Clear(g_c), s | 14.5 | 0.3 | 0.0 | 1.6 | 0.0 | 0.0 | 73.3 | 0.0 | 22.8 | 4.7 | 4.8 | 12.7 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 0.72 | | 0.02 | 0.05 | | 1.00 |
| Lane Grp Cap(c), veh/h | 537 | 531 | 0 | 126 | 0 | 0 | 0 | 0 | 964 | 1081 | 918 | 1200 |
| V/C Ratio(X) | 0.96 | 0.02 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 0.22 | 0.23 | 0.56 |
| Avail Cap(c_a), veh/h | 537 | 893 | 0 | 436 | 0 | 0 | 0 | 0 | 964 | 1081 | 918 | 1200 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 29.0 | 18.8 | 0.0 | 35.3 | 0.0 | 0.0 | 0.0 | 0.0 | 11.1 | 7.4 | 7.4 | 3.2 |
| Incr Delay (d2), s/veh | 29.2 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 0.1 | 0.1 | 0.6 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 8.2 | 0.2 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 | 2.3 | 2.1 | 5.3 |
| LnGrp Delay(d),s/veh | 58.3 | 18.9 | 0.0 | 36.4 | 0.0 | 0.0 | 0.0 | 0.0 | 13.8 | 7.5 | 7.5 | 3.8 |
| LnGrp LOS | E | B | | D | | | | | B | A | A | A |
| Approach Vol, veh/h | | 527 | | | 33 | | | 1011 | | | 1114 | |
| Approach Delay, s/veh | | 57.4 | | | 36.4 | | | 9.5 | | | 5.3 | |
| Approach LOS | | E | | | D | | | A | | | A | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | 48.5 | | 26.5 | | 48.5 | 19.0 | 7.5 |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | 44.0 | | 37.0 | | 34.5 | 14.5 | 18.0 |
| Max Q Clear Time (g_c+I1), s | | 75.3 | | 2.3 | | 14.7 | 16.5 | 3.6 |
| Green Ext Time (p_c), s | | 0.0 | | 0.2 | | 14.2 | 0.0 | 0.1 |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 17.5 |
| HCM 2010 LOS | | | B |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

Intersection Summary

Area Type: Other

Control Type: Roundabout

Intersection Capacity Utilization 70.1% ICU Level of Service C

Analysis Period (min) 15

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Approach Volume (veh/h) | 598 | | | 908 | 962 | |
| Crossing Volume (veh/h) | 457 | | | 255 | 478 | |
| High Capacity (veh/h) | 966 | | | 1134 | 950 | |
| High v/c (veh/h) | 0.62 | | | 0.80 | 1.01 | |
| Low Capacity (veh/h) | 783 | | | 934 | 769 | |
| Low v/c (veh/h) | 0.76 | | | 0.97 | 1.25 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.01 | | |
| Maximum v/c Low | 1.25 | | |
| Intersection Capacity Utilization | 70.1% | ICU Level of Service | C |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 20.2 |
| Intersection LOS | C |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 598 | 908 | 962 |
| Demand Flow Rate, veh/h | 628 | 954 | 1010 |
| Vehicles Circulating, veh/h | 480 | 268 | 502 |
| Vehicles Exiting, veh/h | 742 | 1244 | 606 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 14.1 | 10.8 | 32.9 |
| Approach LOS | B | B | D |

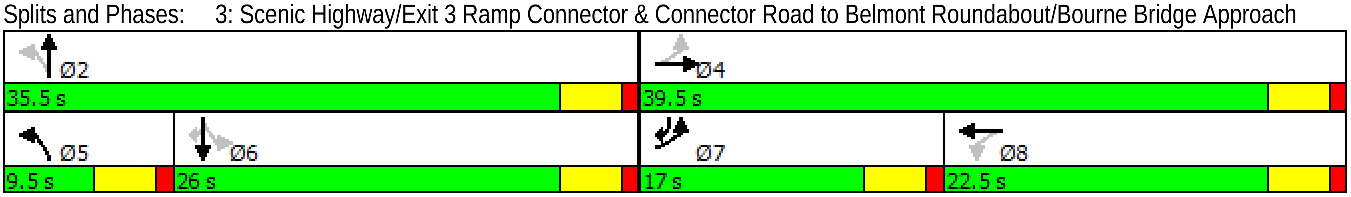
| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.799 | 0.201 | 0.503 | 0.497 | 0.265 | 0.735 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 502 | 126 | 480 | 474 | 268 | 742 |
| Cap Entry Lane, veh/h | 788 | 807 | 924 | 937 | 775 | 795 |
| Entry HV Adj Factor | 0.952 | 0.952 | 0.952 | 0.952 | 0.951 | 0.953 |
| Flow Entry, veh/h | 478 | 120 | 457 | 451 | 255 | 707 |
| Cap Entry, veh/h | 751 | 769 | 880 | 892 | 738 | 758 |
| V/C Ratio | 0.637 | 0.156 | 0.519 | 0.506 | 0.346 | 0.933 |
| Control Delay, s/veh | 16.0 | 6.3 | 11.0 | 10.6 | 9.2 | 41.5 |
| LOS | C | A | B | B | A | E |
| 95th %tile Queue, veh | 5 | 1 | 3 | 3 | 2 | 13 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.998 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.989 | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3393 | 0 | 0 | 3266 | 1538 |
| Flt Permitted | 0.622 | | | | | | | 0.778 | | | 0.283 | |
| Satd. Flow (perm) | 1126 | 1542 | 0 | 0 | 1728 | 0 | 0 | 2669 | 0 | 0 | 973 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 658 | | | 11 | | | 2 | | | | 668 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 516 | 669 | 0 | 0 | 33 | 0 | 0 | 1011 | 0 | 0 | 11 | 668 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 17.0 | 39.5 | | 22.5 | 22.5 | | 9.5 | 35.5 | | 26.0 | 26.0 | 17.0 |
| Total Split (%) | 22.7% | 52.7% | | 30.0% | 30.0% | | 12.7% | 47.3% | | 34.7% | 34.7% | 22.7% |
| Maximum Green (s) | 12.5 | 35.0 | | 18.0 | 18.0 | | 5.0 | 31.0 | | 21.5 | 21.5 | 12.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 17.1 | 17.1 | | | 6.7 | | | 25.5 | | | 15.5 | 33.3 |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.13 | | | 0.49 | | | 0.30 | 0.64 |
| v/c Ratio | 0.99 | 0.71 | | | 0.14 | | | 0.73 | | | 0.04 | 0.55 |
| Control Delay | 60.1 | 6.3 | | | 20.6 | | | 14.8 | | | 14.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 60.1 | 6.3 | | | 20.6 | | | 14.8 | | | 14.8 | 2.5 |
| LOS | E | A | | | C | | | B | | | B | A |
| Approach Delay | | 29.7 | | | 20.6 | | | 14.8 | | | 2.7 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 75 | |
| Actuated Cycle Length: 52 | |
| Natural Cycle: 75 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.99 | |
| Intersection Signal Delay: 18.1 | Intersection LOS: B |
| Intersection Capacity Utilization 79.5% | ICU Level of Service D |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 516 | 669 | 33 | 1011 | 11 | 668 |
| v/c Ratio | 0.99 | 0.71 | 0.14 | 0.73 | 0.04 | 0.55 |
| Control Delay | 60.1 | 6.3 | 20.6 | 14.8 | 14.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 60.1 | 6.3 | 20.6 | 14.8 | 14.8 | 2.5 |
| Queue Length 50th (ft) | ~173 | 2 | 5 | 81 | 1 | 0 |
| Queue Length 95th (ft) | #374 | 63 | 31 | 210 | 6 | 37 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 519 | 1280 | 632 | 1738 | 420 | 1225 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.99 | 0.52 | 0.05 | 0.58 | 0.03 | 0.55 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

## HCM Signalized Intersection Capacity Analysis
## 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge A
01/17/2017

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.99 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1543 | | | 1700 | | | 3394 | | | 3266 | 1538 |
| Flt Permitted | 0.62 | 1.00 | | | 1.00 | | | 0.78 | | | 0.28 | 1.00 |
| Satd. Flow (perm) | 1126 | 1543 | | | 1728 | | | 2672 | | | 975 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| RTOR Reduction (vph) | 0 | 415 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 315 |
| Lane Group Flow (vph) | 516 | 254 | 0 | 0 | 23 | 0 | 0 | 1010 | 0 | 0 | 11 | 353 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 20.2 | 20.2 | | | 2.6 | | | 25.5 | | | 15.8 | 28.9 |
| Effective Green, g (s) | 20.2 | 20.2 | | | 2.6 | | | 25.5 | | | 15.8 | 28.9 |
| Actuated g/C Ratio | 0.37 | 0.37 | | | 0.05 | | | 0.47 | | | 0.29 | 0.53 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 557 | 569 | | | 82 | | | 1314 | | | 281 | 939 |
| v/s Ratio Prot | c0.22 | 0.16 | | | | | | c0.07 | | | | 0.09 |
| v/s Ratio Perm | c0.12 | | | | 0.01 | | | c0.29 | | | 0.01 | 0.14 |
| v/c Ratio | 0.93 | 0.45 | | | 0.27 | | | 0.77 | | | 0.04 | 0.38 |
| Uniform Delay, d1 | 16.0 | 13.0 | | | 25.1 | | | 12.1 | | | 14.0 | 7.6 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 21.5 | 0.6 | | | 1.8 | | | 2.8 | | | 0.1 | 0.3 |
| Delay (s) | 37.5 | 13.6 | | | 27.0 | | | 14.9 | | | 14.0 | 7.8 |
| Level of Service | D | B | | | C | | | B | | | B | A |
| Approach Delay (s) | | 24.0 | | | 27.0 | | | 14.9 | | | 7.9 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 17.1 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 1.02 | | |
| Actuated Cycle Length (s) | 54.7 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 79.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 516 | 11 | 0 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 606 | 595 | 0 | 103 | 22 | 22 | 95 | 875 | 16 | 286 | 814 | 1123 |
| Arrive On Green | 0.21 | 0.33 | 0.00 | 0.04 | 0.04 | 0.04 | 0.52 | 0.52 | 0.52 | 0.52 | 0.00 | 0.52 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 516 | 516 | 516 | 3 | 1681 | 30 | 317 | 1564 | 1538 |
| Grp Volume(v), veh/h | 516 | 11 | 0 | 33 | 0 | 0 | 415 | 0 | 596 | 11 | 0 | 668 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1547 | 0 | 0 | 73 | 0 | 1642 | 317 | 1564 | 1538 |
| Q Serve(g_s), s | 12.5 | 0.2 | 0.0 | 1.2 | 0.0 | 0.0 | 37.5 | 0.0 | 16.3 | 0.8 | 0.0 | 12.3 |
| Cycle Q Clear(g_c), s | 12.5 | 0.2 | 0.0 | 1.2 | 0.0 | 0.0 | 37.5 | 0.0 | 16.3 | 17.1 | 0.0 | 12.3 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 0.55 | | 0.02 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 606 | 595 | 0 | 148 | 0 | 0 | 0 | 0 | 854 | 286 | 814 | 1123 |
| V/C Ratio(X) | 0.85 | 0.02 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | 0.04 | 0.00 | 0.59 |
| Avail Cap(c_a), veh/h | 606 | 1063 | 0 | 548 | 0 | 0 | 0 | 0 | 854 | 286 | 814 | 1123 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 |
| Uniform Delay (d), s/veh | 21.6 | 13.5 | 0.0 | 27.9 | 0.0 | 0.0 | 0.0 | 0.0 | 10.8 | 17.2 | 0.0 | 3.8 |
| Incr Delay (d2), s/veh | 11.1 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 0.1 | 0.0 | 0.9 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 4.3 | 0.1 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 7.9 | 0.1 | 0.0 | 5.3 |
| LnGrp Delay(d),s/veh | 32.7 | 13.5 | 0.0 | 28.6 | 0.0 | 0.0 | 0.0 | 0.0 | 13.3 | 17.2 | 0.0 | 4.7 |
| LnGrp LOS | C | B | | C | | | | | B | B | | A |
| Approach Vol, veh/h | | 527 | | | 33 | | | 1011 | | | 679 | |
| Approach Delay, s/veh | | 32.3 | | | 28.6 | | | 7.8 | | | 4.9 | |
| Approach LOS | | C | | | C | | | A | | | A | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | 35.5 | | 24.1 | | 35.5 | 17.0 | 7.1 |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | 31.0 | | 35.0 | | 21.5 | 12.5 | 18.0 |
| Max Q Clear Time (g_c+I1), s | | 39.5 | | 2.2 | | 19.1 | 14.5 | 3.2 |
| Green Ext Time (p_c), s | | 0.0 | | 0.2 | | 2.0 | 0.0 | 0.1 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 13.0 |
| HCM 2010 LOS | B |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 70.1% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Approach Volume (veh/h) | 598 | | | 908 | 962 | |
| Crossing Volume (veh/h) | 457 | | | 255 | 478 | |
| High Capacity (veh/h) | 966 | | | 1134 | 950 | |
| High v/c (veh/h) | 0.62 | | | 0.80 | 1.01 | |
| Low Capacity (veh/h) | 783 | | | 934 | 769 | |
| Low v/c (veh/h) | 0.76 | | | 0.97 | 1.25 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.01 | | |
| Maximum v/c Low | 1.25 | | |
| Intersection Capacity Utilization | 70.1% | ICU Level of Service | C |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 20.2 |
| Intersection LOS | C |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 598 | 908 | 962 |
| Demand Flow Rate, veh/h | 628 | 954 | 1010 |
| Vehicles Circulating, veh/h | 480 | 268 | 502 |
| Vehicles Exiting, veh/h | 742 | 1244 | 606 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 14.1 | 10.8 | 32.9 |
| Approach LOS | B | B | D |

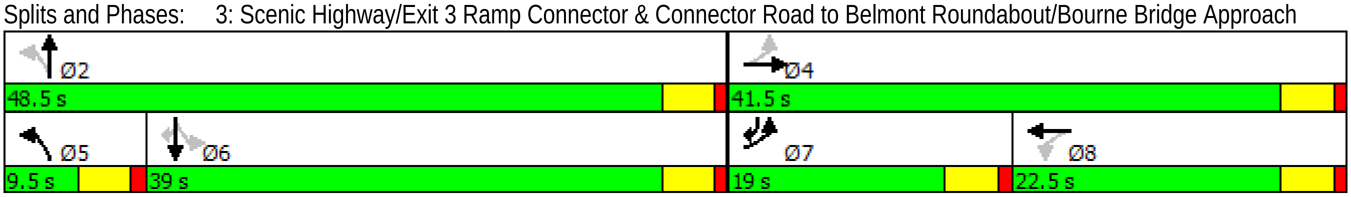
| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.799 | 0.201 | 0.503 | 0.497 | 0.265 | 0.735 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 502 | 126 | 480 | 474 | 268 | 742 |
| Cap Entry Lane, veh/h | 788 | 807 | 924 | 937 | 775 | 795 |
| Entry HV Adj Factor | 0.952 | 0.952 | 0.952 | 0.952 | 0.951 | 0.953 |
| Flow Entry, veh/h | 478 | 120 | 457 | 451 | 255 | 707 |
| Cap Entry, veh/h | 751 | 769 | 880 | 892 | 738 | 758 |
| V/C Ratio | 0.637 | 0.156 | 0.519 | 0.506 | 0.346 | 0.933 |
| Control Delay, s/veh | 16.0 | 6.3 | 11.0 | 10.6 | 9.2 | 41.5 |
| LOS | C | A | B | B | A | E |
| 95th %tile Queue, veh | 5 | 1 | 3 | 3 | 2 | 13 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.998 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.989 | | | 0.999 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3393 | 0 | 0 | 3435 | 1538 |
| Flt Permitted | 0.669 | | | | 0.645 | | | 0.663 | | | 0.925 | |
| Satd. Flow (perm) | 1211 | 1542 | 0 | 0 | 1115 | 0 | 0 | 2275 | 0 | 0 | 3180 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 355 | | | 11 | | | 2 | | | | 668 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 516 | 669 | 0 | 0 | 33 | 0 | 0 | 1011 | 0 | 0 | 446 | 668 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 19.0 | 41.5 | | 22.5 | 22.5 | | 9.5 | 48.5 | | 39.0 | 39.0 | 19.0 |
| Total Split (%) | 21.1% | 46.1% | | 25.0% | 25.0% | | 10.6% | 53.9% | | 43.3% | 43.3% | 21.1% |
| Maximum Green (s) | 14.5 | 37.0 | | 18.0 | 18.0 | | 5.0 | 44.0 | | 34.5 | 34.5 | 14.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 26.8 | 26.8 | | | 10.7 | | | 37.0 | | | 26.8 | 48.6 |
| Actuated g/C Ratio | 0.36 | 0.36 | | | 0.15 | | | 0.50 | | | 0.36 | 0.66 |
| v/c Ratio | 0.92 | 0.85 | | | 0.19 | | | 0.82 | | | 0.38 | 0.54 |
| Control Delay | 47.9 | 22.1 | | | 25.7 | | | 22.9 | | | 18.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 47.9 | 22.1 | | | 25.7 | | | 22.9 | | | 18.8 | 2.5 |
| LOS | D | C | | | C | | | C | | | B | A |
| Approach Delay | | 33.3 | | | 25.7 | | | 22.9 | | | 9.0 | |
| Approach LOS | | C | | | C | | | C | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 90 | |
| Actuated Cycle Length: 73.5 | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.92 | |
| Intersection Signal Delay: 22.0 | Intersection LOS: C |
| Intersection Capacity Utilization 86.6% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 516 | 669 | 33 | 1011 | 446 | 668 |
| v/c Ratio | 0.92 | 0.85 | 0.19 | 0.82 | 0.38 | 0.54 |
| Control Delay | 47.9 | 22.1 | 25.7 | 22.9 | 18.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 47.9 | 22.1 | 25.7 | 22.9 | 18.8 | 2.5 |
| Queue Length 50th (ft) | ~242 | 155 | 10 | 165 | 77 | 0 |
| Queue Length 95th (ft) | #463 | #322 | 36 | #290 | 133 | 42 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 558 | 996 | 301 | 1544 | 1602 | 1243 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.92 | 0.67 | 0.11 | 0.65 | 0.28 | 0.54 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.99 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1543 | | | 1700 | | | 3394 | | | 3434 | 1538 |
| Flt Permitted | 0.67 | 1.00 | | | 0.65 | | | 0.66 | | | 0.93 | 1.00 |
| Satd. Flow (perm) | 1210 | 1543 | | | 1115 | | | 2277 | | | 3181 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| RTOR Reduction (vph) | 0 | 218 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 275 |
| Lane Group Flow (vph) | 516 | 451 | 0 | 0 | 23 | 0 | 0 | 1010 | 0 | 0 | 446 | 393 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 29.0 | 29.0 | | | 7.5 | | | 37.0 | | | 27.1 | 44.1 |
| Effective Green, g (s) | 29.0 | 29.0 | | | 7.5 | | | 37.0 | | | 27.1 | 44.1 |
| Actuated g/C Ratio | 0.39 | 0.39 | | | 0.10 | | | 0.49 | | | 0.36 | 0.59 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 583 | 596 | | | 111 | | | 1203 | | | 1149 | 996 |
| v/s Ratio Prot | c0.20 | 0.29 | | | | | | c0.06 | | | | 0.09 |
| v/s Ratio Perm | c0.14 | | | | 0.02 | | | c0.35 | | | 0.14 | 0.17 |
| v/c Ratio | 0.89 | 0.76 | | | 0.21 | | | 0.84 | | | 0.39 | 0.39 |
| Uniform Delay, d1 | 20.8 | 19.9 | | | 31.0 | | | 16.4 | | | 17.8 | 8.3 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 14.9 | 5.5 | | | 0.9 | | | 5.3 | | | 0.2 | 0.3 |
| Delay (s) | 35.8 | 25.4 | | | 32.0 | | | 21.7 | | | 18.0 | 8.5 |
| Level of Service | D | C | | | C | | | C | | | B | A |
| Approach Delay (s) | | 29.9 | | | 32.0 | | | 21.7 | | | 12.3 | |
| Approach LOS | | C | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.98 | | |
| Actuated Cycle Length (s) | 75.0 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 86.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Future Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 400 | 615 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 516 | 11 | 0 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 435 | 668 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 537 | 531 | 0 | 84 | 22 | 21 | 84 | 967 | 15 | 68 | 1930 | 1200 |
| Arrive On Green | 0.19 | 0.29 | 0.00 | 0.04 | 0.04 | 0.04 | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 492 | 544 | 518 | 3 | 1649 | 26 | 31 | 3290 | 1538 |
| Grp Volume(v), veh/h | 516 | 11 | 0 | 33 | 0 | 0 | 315 | 0 | 696 | 236 | 210 | 668 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1554 | 0 | 0 | 35 | 0 | 1642 | 1757 | 1564 | 1538 |
| Q Serve(g_s), s | 14.5 | 0.3 | 0.0 | 1.4 | 0.0 | 0.0 | 73.3 | 0.0 | 22.8 | 0.0 | 4.8 | 12.7 |
| Cycle Q Clear(g_c), s | 14.5 | 0.3 | 0.0 | 1.6 | 0.0 | 0.0 | 73.3 | 0.0 | 22.8 | 4.7 | 4.8 | 12.7 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 0.72 | | 0.02 | 0.05 | | 1.00 |
| Lane Grp Cap(c), veh/h | 537 | 531 | 0 | 126 | 0 | 0 | 0 | 0 | 964 | 1081 | 918 | 1200 |
| V/C Ratio(X) | 0.96 | 0.02 | 0.00 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 0.22 | 0.23 | 0.56 |
| Avail Cap(c_a), veh/h | 537 | 893 | 0 | 436 | 0 | 0 | 0 | 0 | 964 | 1081 | 918 | 1200 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 29.0 | 18.8 | 0.0 | 35.3 | 0.0 | 0.0 | 0.0 | 0.0 | 11.1 | 7.4 | 7.4 | 3.2 |
| Incr Delay (d2), s/veh | 29.2 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 0.1 | 0.1 | 0.6 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 8.2 | 0.2 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 | 2.3 | 2.1 | 5.3 |
| LnGrp Delay(d),s/veh | 58.3 | 18.9 | 0.0 | 36.4 | 0.0 | 0.0 | 0.0 | 0.0 | 13.8 | 7.5 | 7.5 | 3.8 |
| LnGrp LOS | E | B | | D | | | | | B | A | A | A |
| Approach Vol, veh/h | | 527 | | | 33 | | | 1011 | | | 1114 | |
| Approach Delay, s/veh | | 57.4 | | | 36.4 | | | 9.5 | | | 5.3 | |
| Approach LOS | | E | | | D | | | A | | | A | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | 48.5 | | 26.5 | | 48.5 | 19.0 | 7.5 |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | 44.0 | | 37.0 | | 34.5 | 14.5 | 18.0 |
| Max Q Clear Time (g_c+I1), s | | 75.3 | | 2.3 | | 14.7 | 16.5 | 3.6 |
| Green Ext Time (p_c), s | | 0.0 | | 0.2 | | 14.2 | 0.0 | 0.1 |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2010 Ctrl Delay | | | 17.5 |
| HCM 2010 LOS | | | B |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

Intersection Summary

Area Type: Other
Control Type: Roundabout
Intersection Capacity Utilization 70.1% ICU Level of Service C
Analysis Period (min) 15

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Approach Volume (veh/h) | 598 | | | 908 | 962 | |
| Crossing Volume (veh/h) | 457 | | | 255 | 478 | |
| High Capacity (veh/h) | 966 | | | 1134 | 950 | |
| High v/c (veh/h) | 0.62 | | | 0.80 | 1.01 | |
| Low Capacity (veh/h) | 783 | | | 934 | 769 | |
| Low v/c (veh/h) | 0.76 | | | 0.97 | 1.25 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.01 | | |
| Maximum v/c Low | 1.25 | | |
| Intersection Capacity Utilization | 70.1% | ICU Level of Service | C |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 20.2 |
| Intersection LOS | C |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 598 | 908 | 962 |
| Demand Flow Rate, veh/h | 628 | 954 | 1010 |
| Vehicles Circulating, veh/h | 480 | 268 | 502 |
| Vehicles Exiting, veh/h | 742 | 1244 | 606 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 14.1 | 10.8 | 32.9 |
| Approach LOS | B | B | D |

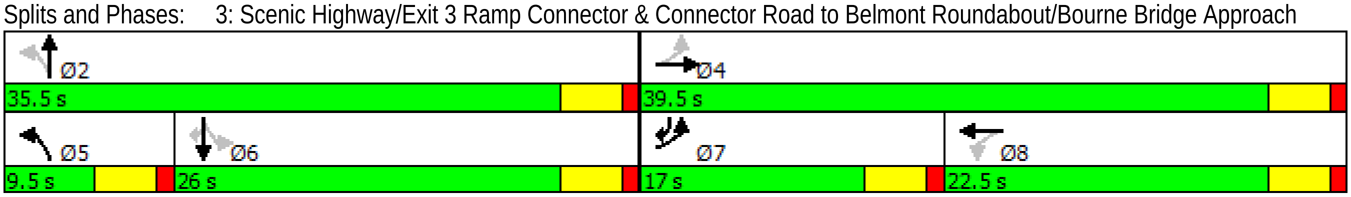
| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.799 | 0.201 | 0.503 | 0.497 | 0.265 | 0.735 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 502 | 126 | 480 | 474 | 268 | 742 |
| Cap Entry Lane, veh/h | 788 | 807 | 924 | 937 | 775 | 795 |
| Entry HV Adj Factor | 0.952 | 0.952 | 0.952 | 0.952 | 0.951 | 0.953 |
| Flow Entry, veh/h | 478 | 120 | 457 | 451 | 255 | 707 |
| Cap Entry, veh/h | 751 | 769 | 880 | 892 | 738 | 758 |
| V/C Ratio | 0.637 | 0.156 | 0.519 | 0.506 | 0.346 | 0.933 |
| Control Delay, s/veh | 16.0 | 6.3 | 11.0 | 10.6 | 9.2 | 41.5 |
| LOS | C | A | B | B | A | E |
| 95th %tile Queue, veh | 5 | 1 | 3 | 3 | 2 | 13 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.998 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.989 | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3393 | 0 | 0 | 3266 | 1538 |
| Flt Permitted | 0.622 | | | | | | | 0.778 | | | 0.283 | |
| Satd. Flow (perm) | 1126 | 1542 | 0 | 0 | 1728 | 0 | 0 | 2669 | 0 | 0 | 973 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 658 | | | 11 | | | 2 | | | | 668 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 516 | 669 | 0 | 0 | 33 | 0 | 0 | 1011 | 0 | 0 | 11 | 668 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 17.0 | 39.5 | | 22.5 | 22.5 | | 9.5 | 35.5 | | 26.0 | 26.0 | 17.0 |
| Total Split (%) | 22.7% | 52.7% | | 30.0% | 30.0% | | 12.7% | 47.3% | | 34.7% | 34.7% | 22.7% |
| Maximum Green (s) | 12.5 | 35.0 | | 18.0 | 18.0 | | 5.0 | 31.0 | | 21.5 | 21.5 | 12.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 17.1 | 17.1 | | | 6.7 | | | 25.5 | | | 15.5 | 33.3 |
| Actuated g/C Ratio | 0.33 | 0.33 | | | 0.13 | | | 0.49 | | | 0.30 | 0.64 |
| v/c Ratio | 0.99 | 0.71 | | | 0.14 | | | 0.73 | | | 0.04 | 0.55 |
| Control Delay | 60.1 | 6.3 | | | 20.6 | | | 14.8 | | | 14.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 60.1 | 6.3 | | | 20.6 | | | 14.8 | | | 14.8 | 2.5 |
| LOS | E | A | | | C | | | B | | | B | A |
| Approach Delay | | 29.7 | | | 20.6 | | | 14.8 | | | 2.7 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 75 | |
| Actuated Cycle Length: 52 | |
| Natural Cycle: 75 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.99 | |
| Intersection Signal Delay: 18.1 | Intersection LOS: B |
| Intersection Capacity Utilization 79.5% | ICU Level of Service D |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 516 | 669 | 33 | 1011 | 11 | 668 |
| v/c Ratio | 0.99 | 0.71 | 0.14 | 0.73 | 0.04 | 0.55 |
| Control Delay | 60.1 | 6.3 | 20.6 | 14.8 | 14.8 | 2.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 60.1 | 6.3 | 20.6 | 14.8 | 14.8 | 2.5 |
| Queue Length 50th (ft) | ~173 | 2 | 5 | 81 | 1 | 0 |
| Queue Length 95th (ft) | #374 | 63 | 31 | 210 | 6 | 37 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 519 | 1280 | 632 | 1738 | 420 | 1225 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.99 | 0.52 | 0.05 | 0.58 | 0.03 | 0.55 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (vph) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.99 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1543 | | | 1700 | | | 3394 | | | 3266 | 1538 |
| Flt Permitted | 0.62 | 1.00 | | | 1.00 | | | 0.78 | | | 0.28 | 1.00 |
| Satd. Flow (perm) | 1126 | 1543 | | | 1728 | | | 2672 | | | 975 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 516 | 11 | 658 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| RTOR Reduction (vph) | 0 | 415 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 0 | 0 | 315 |
| Lane Group Flow (vph) | 516 | 254 | 0 | 0 | 23 | 0 | 0 | 1010 | 0 | 0 | 11 | 353 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 20.2 | 20.2 | | | 2.6 | | | 25.5 | | | 15.8 | 28.9 |
| Effective Green, g (s) | 20.2 | 20.2 | | | 2.6 | | | 25.5 | | | 15.8 | 28.9 |
| Actuated g/C Ratio | 0.37 | 0.37 | | | 0.05 | | | 0.47 | | | 0.29 | 0.53 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 557 | 569 | | | 82 | | | 1314 | | | 281 | 939 |
| v/s Ratio Prot | c0.22 | 0.16 | | | | | | c0.07 | | | | 0.09 |
| v/s Ratio Perm | c0.12 | | | | 0.01 | | | c0.29 | | | 0.01 | 0.14 |
| v/c Ratio | 0.93 | 0.45 | | | 0.27 | | | 0.77 | | | 0.04 | 0.38 |
| Uniform Delay, d1 | 16.0 | 13.0 | | | 25.1 | | | 12.1 | | | 14.0 | 7.6 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 21.5 | 0.6 | | | 1.8 | | | 2.8 | | | 0.1 | 0.3 |
| Delay (s) | 37.5 | 13.6 | | | 27.0 | | | 14.9 | | | 14.0 | 7.8 |
| Level of Service | D | B | | | C | | | B | | | B | A |
| Approach Delay (s) | | 24.0 | | | 27.0 | | | 14.9 | | | 7.9 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 17.1 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 1.02 | | |
| Actuated Cycle Length (s) | 54.7 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 79.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Future Volume (veh/h) | 475 | 10 | 605 | 10 | 10 | 10 | 210 | 710 | 10 | 10 | 0 | 615 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 516 | 11 | 0 | 11 | 11 | 11 | 228 | 772 | 11 | 11 | 0 | 668 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 606 | 595 | 0 | 103 | 22 | 22 | 95 | 875 | 16 | 286 | 814 | 1123 |
| Arrive On Green | 0.21 | 0.33 | 0.00 | 0.04 | 0.04 | 0.04 | 0.52 | 0.52 | 0.52 | 0.52 | 0.00 | 0.52 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 516 | 516 | 516 | 3 | 1681 | 30 | 317 | 1564 | 1538 |
| Grp Volume(v), veh/h | 516 | 11 | 0 | 33 | 0 | 0 | 415 | 0 | 596 | 11 | 0 | 668 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1547 | 0 | 0 | 73 | 0 | 1642 | 317 | 1564 | 1538 |
| Q Serve(g_s), s | 12.5 | 0.2 | 0.0 | 1.2 | 0.0 | 0.0 | 37.5 | 0.0 | 16.3 | 0.8 | 0.0 | 12.3 |
| Cycle Q Clear(g_c), s | 12.5 | 0.2 | 0.0 | 1.2 | 0.0 | 0.0 | 37.5 | 0.0 | 16.3 | 17.1 | 0.0 | 12.3 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 0.55 | | 0.02 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 606 | 595 | 0 | 148 | 0 | 0 | 0 | 0 | 854 | 286 | 814 | 1123 |
| V/C Ratio(X) | 0.85 | 0.02 | 0.00 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | 0.04 | 0.00 | 0.59 |
| Avail Cap(c_a), veh/h | 606 | 1063 | 0 | 548 | 0 | 0 | 0 | 0 | 854 | 286 | 814 | 1123 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 |
| Uniform Delay (d), s/veh | 21.6 | 13.5 | 0.0 | 27.9 | 0.0 | 0.0 | 0.0 | 0.0 | 10.8 | 17.2 | 0.0 | 3.8 |
| Incr Delay (d2), s/veh | 11.1 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 0.1 | 0.0 | 0.9 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 4.3 | 0.1 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 7.9 | 0.1 | 0.0 | 5.3 |
| LnGrp Delay(d),s/veh | 32.7 | 13.5 | 0.0 | 28.6 | 0.0 | 0.0 | 0.0 | 0.0 | 13.3 | 17.2 | 0.0 | 4.7 |
| LnGrp LOS | C | B | | C | | | | | B | B | | A |
| Approach Vol, veh/h | | 527 | | | 33 | | | 1011 | | | 679 | |
| Approach Delay, s/veh | | 32.3 | | | 28.6 | | | 7.8 | | | 4.9 | |
| Approach LOS | | C | | | C | | | A | | | A | |
| **Timer** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | |
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 | | | | |
| Phs Duration (G+Y+Rc), s | | 35.5 | | 24.1 | | 35.5 | 17.0 | 7.1 | | | | |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 | | | | |
| Max Green Setting (Gmax), s | | 31.0 | | 35.0 | | 21.5 | 12.5 | 18.0 | | | | |
| Max Q Clear Time (g_c+I1), s | | 39.5 | | 2.2 | | 19.1 | 14.5 | 3.2 | | | | |
| Green Ext Time (p_c), s | | 0.0 | | 0.2 | | 2.0 | 0.0 | 0.1 | | | | |
| **Intersection Summary** | | | | | | | | | | | | |
| HCM 2010 Ctrl Delay | | | 13.0 | | | | | | | | | |
| HCM 2010 LOS | | | B | | | | | | | | | |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (vph) | 440 | 110 | 420 | 415 | 235 | 650 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 70.1% | ICU Level of Service C |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Future Volume (veh/h) | 440 | 110 | 420 | 415 | 235 | 650 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 478 | 120 | 457 | 451 | 255 | 707 |
| Approach Volume (veh/h) | 598 | | | 908 | 962 | |
| Crossing Volume (veh/h) | 457 | | | 255 | 478 | |
| High Capacity (veh/h) | 966 | | | 1134 | 950 | |
| High v/c (veh/h) | 0.62 | | | 0.80 | 1.01 | |
| Low Capacity (veh/h) | 783 | | | 934 | 769 | |
| Low v/c (veh/h) | 0.76 | | | 0.97 | 1.25 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.01 | | |
| Maximum v/c Low | 1.25 | | |
| Intersection Capacity Utilization | 70.1% | ICU Level of Service | C |

| Intersection | | | | | | | |
|---|---|---|---|---|---|---|---|
| Intersection Delay, s/veh | 20.2 | | | | | | |
| Intersection LOS | C | | | | | | |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 598 | 908 | 962 |
| Demand Flow Rate, veh/h | 628 | 954 | 1010 |
| Vehicles Circulating, veh/h | 480 | 268 | 502 |
| Vehicles Exiting, veh/h | 742 | 1244 | 606 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 14.1 | 10.8 | 32.9 |
| Approach LOS | B | B | D |

| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.799 | 0.201 | 0.503 | 0.497 | 0.265 | 0.735 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 502 | 126 | 480 | 474 | 268 | 742 |
| Cap Entry Lane, veh/h | 788 | 807 | 924 | 937 | 775 | 795 |
| Entry HV Adj Factor | 0.952 | 0.952 | 0.952 | 0.952 | 0.951 | 0.953 |
| Flow Entry, veh/h | 478 | 120 | 457 | 451 | 255 | 707 |
| Cap Entry, veh/h | 751 | 769 | 880 | 892 | 738 | 758 |
| V/C Ratio | 0.637 | 0.156 | 0.519 | 0.506 | 0.346 | 0.933 |
| Control Delay, s/veh | 16.0 | 6.3 | 11.0 | 10.6 | 9.2 | 41.5 |
| LOS | C | A | B | B | A | E |
| 95th %tile Queue, veh | 5 | 1 | 3 | 3 | 2 | 13 |

## Lanes, Volumes, Timings
## 2: Main St/Connector to Exit 3 Ramps & Buzzards Bay Bypass/Scenic Hwy

01/17/2017

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 175 | 260 | 110 | 70 | 140 | 0 | 235 | 300 | 0 | 400 | 345 | 270 |
| Future Volume (vph) | 175 | 260 | 110 | 70 | 140 | 0 | 235 | 300 | 0 | 400 | 345 | 270 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.973 | | | | | | | | | 0.934 | |
| Flt Protected | | 0.984 | | | 0.984 | | | 0.979 | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1783 | 0 | 0 | 1833 | 0 | 0 | 1824 | 0 | 1770 | 1740 | 0 |
| Flt Permitted | | 0.984 | | | 0.984 | | | 0.979 | | 0.950 | | |
| Satd. Flow (perm) | 0 | 1783 | 0 | 0 | 1833 | 0 | 0 | 1824 | 0 | 1770 | 1740 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 342 | | | 237 | | | 185 | | | 480 | |
| Travel Time (s) | | 7.8 | | | 5.4 | | | 4.2 | | | 10.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Adj. Flow (vph) | 190 | 283 | 120 | 76 | 152 | 0 | 255 | 326 | 0 | 435 | 375 | 293 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 593 | 0 | 0 | 228 | 0 | 0 | 581 | 0 | 435 | 668 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Yield | | | Yield | | | Yield | | | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 112.4% | ICU Level of Service H |
| Analysis Period (min) 15 | |

HCM Unsignalized Intersection Capacity Analysis
2: Main St/Connector to Exit 3 Ramps & Buzzards Bay Bypass/Scenic Hwy 01/17/2017

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Right Turn Channelized | | | MOYes | | | | | | | | | MOYes |
| Traffic Volume (veh/h) | 175 | 260 | 110 | 70 | 140 | 0 | 235 | 300 | 0 | 400 | 345 | 270 |
| Future Volume (veh/h) | 175 | 260 | 110 | 70 | 140 | 0 | 235 | 300 | 0 | 400 | 345 | 270 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 190 | 283 | 120 | 76 | 152 | 0 | 255 | 326 | 0 | 435 | 375 | 293 |
| Approach Volume (veh/h) | | 473 | | | 228 | | | 581 | | | 810 | |
| Crossing Volume (veh/h) | | 886 | | | 771 | | | 908 | | | 483 | |
| High Capacity (veh/h) | | 683 | | | 750 | | | 671 | | | 946 | |
| High v/c (veh/h) | | 0.69 | | | 0.30 | | | 0.87 | | | 0.86 | |
| Low Capacity (veh/h) | | 535 | | | 593 | | | 525 | | | 766 | |
| Low v/c (veh/h) | | 0.88 | | | 0.38 | | | 1.11 | | | 1.06 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 0.87 | | |
| Maximum v/c Low | 1.11 | | |
| Intersection Capacity Utilization | 112.4% | ICU Level of Service | H |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 68.5 |
| Intersection LOS | F |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 2 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 593 | 228 | 581 | 1103 |
| Demand Flow Rate, veh/h | 605 | 233 | 593 | 1125 |
| Vehicles Circulating, veh/h | 904 | 787 | 927 | 493 |
| Vehicles Exiting, veh/h | 415 | 733 | 460 | 527 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 72.1 | 15.2 | 188.0 | 14.6 |
| Approach LOS | F | C | F | B |

| Lane | Left | Bypass | Left | Left | Left | Right | Bypass |
|---|---|---|---|---|---|---|---|
| Designated Moves | LT | R | LT | LTR | L | TR | R |
| Assumed Moves | LT | R | LT | LTR | L | TR | R |
| RT Channelized | | Yield | | | | | Yield |
| Lane Util | 1.000 | | 1.000 | 1.000 | 0.538 | 0.462 | |
| Critical Headway, s | 5.193 | | 5.193 | 5.193 | 5.193 | 5.193 | |
| Entry Flow, veh/h | 483 | 122 | 233 | 593 | 444 | 382 | 299 |
| Cap Entry Lane, veh/h | 458 | 713 | 514 | 447 | 690 | 690 | 746 |
| Entry HV Adj Factor | 0.980 | 0.980 | 0.978 | 0.981 | 0.980 | 0.980 | 0.980 |
| Flow Entry, veh/h | 473 | 120 | 228 | 581 | 435 | 375 | 293 |
| Cap Entry, veh/h | 448 | 699 | 503 | 438 | 676 | 677 | 732 |
| V/C Ratio | 1.056 | 0.172 | 0.453 | 1.326 | 0.643 | 0.553 | 0.401 |
| Control Delay, s/veh | 88.5 | 7.1 | 15.2 | 188.0 | 17.6 | 14.5 | 10.2 |
| LOS | F | A | C | F | C | B | B |
| 95th %tile Queue, veh | 15 | 1 | 2 | 26 | 5 | 3 | 2 |

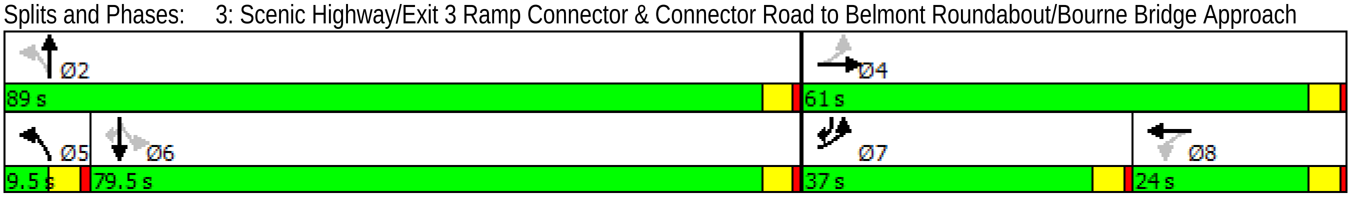
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Future Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.999 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.982 | | | 0.999 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3373 | 0 | 0 | 3435 | 1538 |
| Flt Permitted | 0.667 | | | | 0.301 | | | 0.573 | | | 0.917 | |
| Satd. Flow (perm) | 1207 | 1542 | 0 | 0 | 520 | 0 | 0 | 1968 | 0 | 0 | 3153 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 283 | | | 11 | | | 1 | | | | 812 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 712 | 11 | 924 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 598 | 908 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 712 | 935 | 0 | 0 | 33 | 0 | 0 | 1337 | 0 | 0 | 609 | 908 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 37.0 | 61.0 | | 24.0 | 24.0 | | 9.5 | 89.0 | | 79.5 | 79.5 | 37.0 |
| Total Split (%) | 24.7% | 40.7% | | 16.0% | 16.0% | | 6.3% | 59.3% | | 53.0% | 53.0% | 24.7% |
| Maximum Green (s) | 32.5 | 56.5 | | 19.5 | 19.5 | | 5.0 | 84.5 | | 75.0 | 75.0 | 32.5 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 56.5 | 56.5 | | | 16.7 | | | 84.5 | | | 75.0 | 116.8 |
| Actuated g/C Ratio | 0.38 | 0.38 | | | 0.11 | | | 0.56 | | | 0.50 | 0.78 |
| v/c Ratio | 1.23 | 1.24 | | | 0.49 | | | 1.33dl | | | 0.39 | 0.66 |
| Control Delay | 154.5 | 145.5 | | | 69.0 | | | 111.1 | | | 24.2 | 3.4 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 154.5 | 145.5 | | | 69.0 | | | 111.1 | | | 24.2 | 3.4 |
| LOS | F | F | | | E | | | F | | | C | A |
| Approach Delay | | 149.4 | | | 69.0 | | | 111.1 | | | 11.7 | |
| Approach LOS | | F | | | E | | | F | | | B | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Natural Cycle: 150 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 1.24 | |
| Intersection Signal Delay: 91.5 | Intersection LOS: F |
| Intersection Capacity Utilization 114.6% | ICU Level of Service H |
| Analysis Period (min) 15 | |

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 712 | 935 | 33 | 1337 | 609 | 908 |
| v/c Ratio | 1.23 | 1.24 | 0.49 | 1.33dl | 0.39 | 0.66 |
| Control Delay | 154.5 | 145.5 | 69.0 | 111.1 | 24.2 | 3.4 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 154.5 | 145.5 | 69.0 | 111.1 | 24.2 | 3.4 |
| Queue Length 50th (ft) | ~871 | ~950 | 20 | ~646 | 190 | 23 |
| Queue Length 95th (ft) | #1118 | #1213 | 60 | #869 | 238 | 58 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 581 | 757 | 77 | 1155 | 1576 | 1377 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.23 | 1.24 | 0.43 | 1.16 | 0.39 | 0.66 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Future Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.98 | | | 1.00 | 1.00 |
| Satd. Flow (prot) | 1719 | 1541 | | | 1700 | | | 3371 | | | 3435 | 1538 |
| Flt Permitted | 0.67 | 1.00 | | | 0.30 | | | 0.57 | | | 0.92 | 1.00 |
| Satd. Flow (perm) | 1206 | 1541 | | | 520 | | | 1969 | | | 3152 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 712 | 11 | 924 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 598 | 908 |
| RTOR Reduction (vph) | 0 | 175 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 208 |
| Lane Group Flow (vph) | 712 | 760 | 0 | 0 | 23 | 0 | 0 | 1337 | 0 | 0 | 609 | 700 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 57.4 | 57.4 | | | 15.6 | | | 84.5 | | | 75.0 | 112.3 |
| Effective Green, g (s) | 57.4 | 57.4 | | | 15.6 | | | 84.5 | | | 75.0 | 112.3 |
| Actuated g/C Ratio | 0.38 | 0.38 | | | 0.10 | | | 0.56 | | | 0.50 | 0.74 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 585 | 586 | | | 53 | | | 1149 | | | 1566 | 1190 |
| v/s Ratio Prot | 0.30 | c0.49 | | | | | | c0.04 | | | | 0.15 |
| v/s Ratio Perm | 0.16 | | | | 0.04 | | | c0.61 | | | 0.19 | 0.31 |
| v/c Ratio | 1.22 | 1.30 | | | 0.44 | | | 1.33dl | | | 0.39 | 0.59 |
| Uniform Delay, d1 | 45.3 | 46.8 | | | 63.5 | | | 33.2 | | | 23.7 | 8.8 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 112.7 | 145.7 | | | 5.7 | | | 83.3 | | | 0.2 | 0.7 |
| Delay (s) | 158.0 | 192.4 | | | 69.2 | | | 116.5 | | | 23.8 | 9.5 |
| Level of Service | F | F | | | E | | | F | | | C | A |
| Approach Delay (s) | | 177.5 | | | 69.2 | | | 116.5 | | | 15.3 | |
| Approach LOS | | F | | | E | | | F | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 104.5 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.29 | | |
| Actuated Cycle Length (s) | 150.9 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 114.6% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Future Volume (veh/h) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 550 | 835 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 712 | 11 | 0 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 598 | 908 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 534 | 552 | 0 | 49 | 18 | 16 | 55 | 1018 | 14 | 43 | 1945 | 1338 |
| Arrive On Green | 0.24 | 0.31 | 0.00 | 0.03 | 0.03 | 0.03 | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 456 | 588 | 522 | 2 | 1621 | 22 | 24 | 3097 | 1538 |
| Grp Volume(v), veh/h | 712 | 11 | 0 | 33 | 0 | 0 | 500 | 0 | 837 | 305 | 304 | 908 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1566 | 0 | 0 | 2 | 0 | 1643 | 1556 | 1564 | 1538 |
| Q Serve(g_s), s | 32.5 | 0.6 | 0.0 | 2.3 | 0.0 | 0.0 | 150.0 | 0.0 | 52.0 | 2.2 | 12.1 | 25.3 |
| Cycle Q Clear(g_c), s | 32.5 | 0.6 | 0.0 | 2.8 | 0.0 | 0.0 | 150.0 | 0.0 | 52.0 | 54.1 | 12.1 | 25.3 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 1.00 | | 0.01 | 0.04 | | 1.00 |
| Lane Grp Cap(c), veh/h | 534 | 552 | 0 | 83 | 0 | 0 | 0 | 0 | 1032 | 1005 | 983 | 1338 |
| V/C Ratio(X) | 1.33 | 0.02 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.81 | 0.30 | 0.31 | 0.68 |
| Avail Cap(c_a), veh/h | 534 | 760 | 0 | 260 | 0 | 0 | 0 | 0 | 1032 | 1005 | 983 | 1338 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 49.5 | 32.7 | 0.0 | 64.6 | 0.0 | 0.0 | 0.0 | 0.0 | 19.0 | 11.6 | 11.5 | 2.8 |
| Incr Delay (d2), s/veh | 162.7 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.2 | 0.2 | 1.4 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 28.5 | 0.3 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 24.9 | 5.1 | 5.2 | 10.7 |
| LnGrp Delay(d),s/veh | 212.2 | 32.7 | 0.0 | 67.7 | 0.0 | 0.0 | 0.0 | 0.0 | 23.9 | 11.8 | 11.7 | 4.2 |
| LnGrp LOS | F | C | | E | | | | | C | B | B | A |
| Approach Vol, veh/h | | 723 | | | 33 | | | 1337 | | | 1517 | |
| Approach Delay, s/veh | | 209.5 | | | 67.7 | | | 15.0 | | | 7.2 | |
| Approach LOS | | F | | | E | | | B | | | A | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | 89.0 | | 45.5 | | 89.0 | 37.0 | 8.5 |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | 84.5 | | 56.5 | | 75.0 | 32.5 | 19.5 |
| Max Q Clear Time (g_c+I1), s | | 152.0 | | 2.6 | | 56.1 | 34.5 | 4.8 |
| Green Ext Time (p_c), s | | 0.0 | | 0.2 | | 17.9 | 0.0 | 0.1 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 51.2 |
| HCM 2010 LOS | | D |

## 17: Connector Road to Belmont Roundabout



| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Future Volume (vph) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 97.9% | ICU Level of Service F |
| Analysis Period (min) 15 | |

## HCM Unsignalized Intersection Capacity Analysis
## 17: Connector Road to Belmont Roundabout

01/17/2017

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Future Volume (veh/h) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Approach Volume (veh/h) | 733 | | | 1419 | 1521 | |
| Crossing Volume (veh/h) | 1082 | | | 179 | 304 | |
| High Capacity (veh/h) | 582 | | | 1204 | 1091 | |
| High v/c (veh/h) | 1.26 | | | 1.18 | 1.39 | |
| Low Capacity (veh/h) | 448 | | | 997 | 895 | |
| Low v/c (veh/h) | 1.64 | | | 1.42 | 1.70 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.39 | | |
| Maximum v/c Low | 1.70 | | |
| Intersection Capacity Utilization | 97.9% | ICU Level of Service | F |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 137.7 |
| Intersection LOS | F |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 733 | 1419 | 1521 |
| Demand Flow Rate, veh/h | 769 | 1490 | 1597 |
| Vehicles Circulating, veh/h | 1136 | 188 | 319 |
| Vehicles Exiting, veh/h | 542 | 1728 | 1586 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 37.2 | 79.2 | 240.6 |
| Approach LOS | E | F | F |

| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.415 | 0.585 | 0.762 | 0.238 | 0.118 | 0.882 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 319 | 450 | 1136 | 354 | 188 | 1409 |
| Cap Entry Lane, veh/h | 482 | 510 | 981 | 991 | 890 | 904 |
| Entry HV Adj Factor | 0.952 | 0.953 | 0.952 | 0.952 | 0.952 | 0.952 |
| Flow Entry, veh/h | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Cap Entry, veh/h | 459 | 486 | 935 | 943 | 847 | 861 |
| V/C Ratio | 0.662 | 0.882 | 1.158 | 0.357 | 0.211 | 1.559 |
| Control Delay, s/veh | 25.2 | 45.6 | 101.4 | 7.7 | 6.4 | 271.9 |
| LOS | D | E | F | A | A | F |
| 95th %tile Queue, veh | 5 | 10 | 31 | 2 | 1 | 68 |

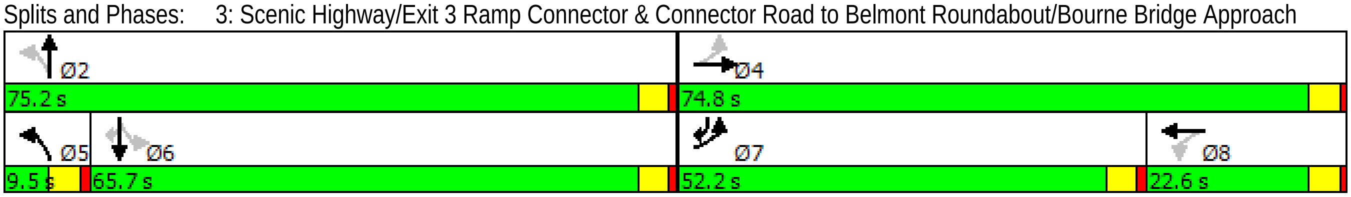
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Future Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 100 |
| Storage Lanes | 1 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 1 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 1.00 |
| Frt | | 0.852 | | | 0.955 | | | 0.999 | | | | 0.850 |
| Flt Protected | 0.950 | | | | 0.984 | | | 0.982 | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1542 | 0 | 0 | 1700 | 0 | 0 | 3373 | 0 | 0 | 3266 | 1538 |
| Flt Permitted | 0.627 | | | | 0.325 | | | 0.801 | | | 0.102 | |
| Satd. Flow (perm) | 1135 | 1542 | 0 | 0 | 562 | 0 | 0 | 2751 | 0 | 0 | 351 | 1538 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 924 | | | 11 | | | 1 | | | | 805 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 466 | | | 399 | | | 232 | | | 313 | |
| Travel Time (s) | | 10.6 | | | 9.1 | | | 5.3 | | | 7.1 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 712 | 11 | 924 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 0 | 908 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 712 | 935 | 0 | 0 | 33 | 0 | 0 | 1337 | 0 | 0 | 11 | 908 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 12 | | | 12 | | | 0 | | | 0 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Number of Detectors | 1 | 2 | | 1 | 2 | | 1 | 2 | | 1 | 2 | 1 |
| Detector Template | Left | Thru | | Left | Thru | | Left | Thru | | Left | Thru | Right |
| Leading Detector (ft) | 20 | 100 | | 20 | 100 | | 20 | 100 | | 20 | 100 | 20 |
| Trailing Detector (ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | | 20 | 6 | | 20 | 6 | | 20 | 6 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | | | 94 | | | 94 | | | 94 | |
| Detector 2 Size(ft) | | 6 | | | 6 | | | 6 | | | 6 | |
| Detector 2 Type | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | | | Cl+Ex | |
| Detector 2 Channel | | | | | | | | | | | | |
| Detector 2 Extend (s) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | | 8 | 8 | | 5 | 2 | | 6 | 6 | 7 |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 22.5 | | 22.5 | 22.5 | | 9.5 | 22.5 | | 22.5 | 22.5 | 9.5 |
| Total Split (s) | 52.2 | 74.8 | | 22.6 | 22.6 | | 9.5 | 75.2 | | 65.7 | 65.7 | 52.2 |
| Total Split (%) | 34.8% | 49.9% | | 15.1% | 15.1% | | 6.3% | 50.1% | | 43.8% | 43.8% | 34.8% |
| Maximum Green (s) | 47.7 | 70.3 | | 18.1 | 18.1 | | 5.0 | 70.7 | | 61.2 | 61.2 | 47.7 |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lead/Lag | Lead | | | Lag | Lag | | Lead | | | Lag | Lag | Lead |
| Lead-Lag Optimize? | Yes | | | Yes | Yes | | Yes | | | Yes | Yes | Yes |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | None | | None | None | | Min | Min | | Min | Min | Min |
| Walk Time (s) | | 7.0 | | 7.0 | 7.0 | | | 7.0 | | 7.0 | 7.0 | |
| Flash Dont Walk (s) | | 11.0 | | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | | 0 | | 0 | 0 | | | 0 | | 0 | 0 | |
| Act Effct Green (s) | 58.7 | 58.7 | | | 10.9 | | | 71.1 | | | 61.5 | 114.0 |
| Actuated g/C Ratio | 0.42 | 0.42 | | | 0.08 | | | 0.51 | | | 0.44 | 0.82 |
| v/c Ratio | 1.05 | 0.79 | | | 0.61 | | | 0.93 | | | 0.07 | 0.65 |
| Control Delay | 84.4 | 7.3 | | | 89.7 | | | 45.1 | | | 27.8 | 3.1 |
| Queue Delay | 0.0 | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | 0.0 |
| Total Delay | 84.4 | 7.3 | | | 89.7 | | | 45.1 | | | 27.8 | 3.1 |
| LOS | F | A | | | F | | | D | | | C | A |
| Approach Delay | | 40.6 | | | 89.7 | | | 45.1 | | | 3.4 | |
| Approach LOS | | D | | | F | | | D | | | A | |

Intersection Summary

Area Type: Other
Cycle Length: 150
Actuated Cycle Length: 138.8
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.05
Intersection Signal Delay: 33.9 Intersection LOS: C
Intersection Capacity Utilization 101.8% ICU Level of Service G
Analysis Period (min) 15

Splits and Phases: 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge Approach



# Queues

## 3: Scenic Highway/Exit 3 Ramp Connector & Connector Road to Belmont Roundabout/Bourne Bridge A

01/17/2017

| Lane Group | EBL | EBT | WBT | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 712 | 935 | 33 | 1337 | 11 | 908 |
| v/c Ratio | 1.05 | 0.79 | 0.61 | 0.93 | 0.07 | 0.65 |
| Control Delay | 84.4 | 7.3 | 89.7 | 45.1 | 27.8 | 3.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 84.4 | 7.3 | 89.7 | 45.1 | 27.8 | 3.1 |
| Queue Length 50th (ft) | ~647 | 6 | 20 | 533 | 3 | 18 |
| Queue Length 95th (ft) | #787 | 107 | 60 | #844 | 11 | 58 |
| Internal Link Dist (ft) | | 386 | 319 | 152 | 233 | |
| Turn Bay Length (ft) | | | | | | 100 |
| Base Capacity (vph) | 681 | 1238 | 83 | 1431 | 155 | 1406 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.05 | 0.76 | 0.40 | 0.93 | 0.07 | 0.65 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Future Volume (vph) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | | 1.00 | | | 0.95 | | | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | | | 0.95 | | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | | 0.98 | | | 0.98 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1541 | | | 1700 | | | 3371 | | | 3266 | 1538 |
| Flt Permitted | 0.63 | 1.00 | | | 0.33 | | | 0.80 | | | 0.10 | 1.00 |
| Satd. Flow (perm) | 1134 | 1541 | | | 562 | | | 2750 | | | 352 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 712 | 11 | 924 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 0 | 908 |
| RTOR Reduction (vph) | 0 | 526 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 179 |
| Lane Group Flow (vph) | 712 | 409 | 0 | 0 | 23 | 0 | 0 | 1337 | 0 | 0 | 11 | 729 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | Perm | NA | pm+ov |
| Protected Phases | 7 | 4 | | | 8 | | 5 | 2 | | | 6 | 7 |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | 6 |
| Actuated Green, G (s) | 60.6 | 60.6 | | | 8.2 | | | 71.0 | | | 61.5 | 109.4 |
| Effective Green, g (s) | 60.6 | 60.6 | | | 8.2 | | | 71.0 | | | 61.5 | 109.4 |
| Actuated g/C Ratio | 0.43 | 0.43 | | | 0.06 | | | 0.50 | | | 0.44 | 0.78 |
| Clearance Time (s) | 4.5 | 4.5 | | | 4.5 | | | 4.5 | | | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 688 | 664 | | | 32 | | | 1410 | | | 153 | 1245 |
| v/s Ratio Prot | c0.35 | 0.27 | | | | | | c0.03 | | | | 0.20 |
| v/s Ratio Perm | c0.09 | | | | 0.04 | | | c0.44 | | | 0.03 | 0.27 |
| v/c Ratio | 1.03 | 0.62 | | | 0.71 | | | 0.95 | | | 0.07 | 0.59 |
| Uniform Delay, d1 | 38.6 | 31.0 | | | 65.0 | | | 33.0 | | | 23.0 | 6.4 |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 43.6 | 1.7 | | | 52.5 | | | 13.4 | | | 0.2 | 0.7 |
| Delay (s) | 82.2 | 32.7 | | | 117.5 | | | 46.4 | | | 23.2 | 7.1 |
| Level of Service | F | C | | | F | | | D | | | C | A |
| Approach Delay (s) | | 54.1 | | | 117.5 | | | 46.4 | | | 7.3 | |
| Approach LOS | | D | | | F | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 41.1 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 1.05 | | |
| Actuated Cycle Length (s) | 140.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 101.8% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Future Volume (veh/h) | 655 | 10 | 850 | 10 | 10 | 10 | 460 | 760 | 10 | 10 | 0 | 835 |
| Number | 7 | 4 | 14 | 3 | 8 | 18 | 5 | 2 | 12 | 1 | 6 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1900 | 1900 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 712 | 11 | 0 | 11 | 11 | 11 | 500 | 826 | 11 | 11 | 0 | 908 |
| Adj No. of Lanes | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 721 | 749 | 0 | 49 | 18 | 16 | 54 | 843 | 11 | 67 | 814 | 1340 |
| Arrive On Green | 0.35 | 0.41 | 0.00 | 0.03 | 0.03 | 0.03 | 0.52 | 0.52 | 0.52 | 0.52 | 0.00 | 0.52 |
| Sat Flow, veh/h | 1723 | 1810 | 0 | 456 | 588 | 522 | 2 | 1621 | 22 | 26 | 1564 | 1538 |
| Grp Volume(v), veh/h | 712 | 11 | 0 | 33 | 0 | 0 | 500 | 0 | 837 | 11 | 0 | 908 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 0 | 1566 | 0 | 0 | 2 | 0 | 1643 | 26 | 1564 | 1538 |
| Q Serve(g_s), s | 47.7 | 0.5 | 0.0 | 2.4 | 0.0 | 0.0 | 150.0 | 0.0 | 67.8 | 2.3 | 0.0 | 25.3 |
| Cycle Q Clear(g_c), s | 47.7 | 0.5 | 0.0 | 2.8 | 0.0 | 0.0 | 150.0 | 0.0 | 67.8 | 70.1 | 0.0 | 25.3 |
| Prop In Lane | 1.00 | | 0.00 | 0.33 | | 0.33 | 1.00 | | 0.01 | 1.00 | | 1.00 |
| Lane Grp Cap(c), veh/h | 721 | 749 | 0 | 82 | 0 | 0 | 0 | 0 | 854 | 67 | 814 | 1340 |
| V/C Ratio(X) | 0.99 | 0.01 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.98 | 0.16 | 0.00 | 0.68 |
| Avail Cap(c_a), veh/h | 721 | 936 | 0 | 242 | 0 | 0 | 0 | 0 | 854 | 67 | 814 | 1340 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 |
| Uniform Delay (d), s/veh | 42.3 | 23.5 | 0.0 | 65.3 | 0.0 | 0.0 | 0.0 | 0.0 | 31.9 | 66.2 | 0.0 | 2.8 |
| Incr Delay (d2), s/veh | 30.4 | 0.0 | 0.0 | 3.2 | 0.0 | 0.0 | 0.0 | 0.0 | 25.7 | 1.1 | 0.0 | 1.4 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 10.1 | 0.2 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 36.8 | 0.4 | 0.0 | 10.7 |
| LnGrp Delay(d),s/veh | 72.7 | 23.5 | 0.0 | 68.5 | 0.0 | 0.0 | 0.0 | 0.0 | 57.6 | 67.4 | 0.0 | 4.2 |
| LnGrp LOS | E | C | | E | | | | | E | E | | A |
| Approach Vol, veh/h | | 723 | | | 33 | | | 1337 | | | 919 | |
| Approach Delay, s/veh | | 71.9 | | | 68.5 | | | 36.1 | | | 4.9 | |
| Approach LOS | | E | | | E | | | D | | | A | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | 75.2 | | 60.8 | | 75.2 | 52.2 | 8.6 |
| Change Period (Y+Rc), s | | 4.5 | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | 70.7 | | 70.3 | | 61.2 | 47.7 | 18.1 |
| Max Q Clear Time (g_c+I1), s | | 152.0 | | 2.5 | | 72.1 | 49.7 | 4.8 |
| Green Ext Time (p_c), s | | 0.0 | | 0.3 | | 0.0 | 0.0 | 0.1 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 35.5 |
| HCM 2010 LOS | | D |

| Lane Group | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Future Volume (vph) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.950 | | 0.950 | |
| Satd. Flow (perm) | 1810 | 1538 | 1719 | 1810 | 1719 | 1538 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 236 | | | 466 | 240 | |
| Travel Time (s) | 5.4 | | | 10.6 | 5.5 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Yield | | | Yield | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 97.9% | ICU Level of Service F |
| Analysis Period (min) 15 | |

## HCM Unsignalized Intersection Capacity Analysis
## 17: Connector Road to Belmont Roundabout

01/17/2017

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Right Turn Channelized | | | | | | |
| Traffic Volume (veh/h) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Future Volume (veh/h) | 280 | 395 | 995 | 310 | 165 | 1235 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Approach Volume (veh/h) | 733 | | | 1419 | 1521 | |
| Crossing Volume (veh/h) | 1082 | | | 179 | 304 | |
| High Capacity (veh/h) | 582 | | | 1204 | 1091 | |
| High v/c (veh/h) | 1.26 | | | 1.18 | 1.39 | |
| Low Capacity (veh/h) | 448 | | | 997 | 895 | |
| Low v/c (veh/h) | 1.64 | | | 1.42 | 1.70 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.39 | | |
| Maximum v/c Low | 1.70 | | |
| Intersection Capacity Utilization | 97.9% | ICU Level of Service | F |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 137.7 |
| Intersection LOS | F |

| Approach | EB | WB | NB |
|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 733 | 1419 | 1521 |
| Demand Flow Rate, veh/h | 769 | 1490 | 1597 |
| Vehicles Circulating, veh/h | 1136 | 188 | 319 |
| Vehicles Exiting, veh/h | 542 | 1728 | 1586 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 37.2 | 79.2 | 240.6 |
| Approach LOS | E | F | F |

| Lane | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|
| Designated Moves | LT | R | L | TR | L | TR |
| Assumed Moves | LT | R | L | TR | L | TR |
| RT Channelized | | | | | | |
| Lane Util | 0.415 | 0.585 | 0.762 | 0.238 | 0.118 | 0.882 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 319 | 450 | 1136 | 354 | 188 | 1409 |
| Cap Entry Lane, veh/h | 482 | 510 | 981 | 991 | 890 | 904 |
| Entry HV Adj Factor | 0.952 | 0.953 | 0.952 | 0.952 | 0.952 | 0.952 |
| Flow Entry, veh/h | 304 | 429 | 1082 | 337 | 179 | 1342 |
| Cap Entry, veh/h | 459 | 486 | 935 | 943 | 847 | 861 |
| V/C Ratio | 0.662 | 0.882 | 1.158 | 0.357 | 0.211 | 1.559 |
| Control Delay, s/veh | 25.2 | 45.6 | 101.4 | 7.7 | 6.4 | 271.9 |
| LOS | D | E | F | A | A | F |
| 95th %tile Queue, veh | 5 | 10 | 31 | 2 | 1 | 68 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 125 | 150 | 395 | 285 | 175 | 0 | 165 | 530 | 0 | 550 | 705 | 130 |
| Future Volume (vph) | 125 | 150 | 395 | 285 | 175 | 0 | 165 | 530 | 0 | 550 | 705 | 130 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.920 | | | | | | | | | 0.977 | |
| Flt Protected | | 0.991 | | | 0.970 | | | 0.988 | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1698 | 0 | 0 | 1807 | 0 | 0 | 1840 | 0 | 1770 | 1820 | 0 |
| Flt Permitted | | 0.991 | | | 0.970 | | | 0.988 | | 0.950 | | |
| Satd. Flow (perm) | 0 | 1698 | 0 | 0 | 1807 | 0 | 0 | 1840 | 0 | 1770 | 1820 | 0 |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 342 | | | 237 | | | 185 | | | 480 | |
| Travel Time (s) | | 7.8 | | | 5.4 | | | 4.2 | | | 10.9 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Adj. Flow (vph) | 136 | 163 | 429 | 310 | 190 | 0 | 179 | 576 | 0 | 598 | 766 | 141 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 728 | 0 | 0 | 500 | 0 | 0 | 755 | 0 | 598 | 907 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(ft) | | 0 | | | 0 | | | 12 | | | 12 | |
| Link Offset(ft) | | 0 | | | 0 | | | 0 | | | 0 | |
| Crosswalk Width(ft) | | 16 | | | 16 | | | 16 | | | 16 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | 9 | 15 | | 9 | 15 | | 9 | 15 | | 9 |
| Sign Control | | Yield | | | Yield | | | Yield | | | Yield | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Roundabout | |
| Intersection Capacity Utilization 158.2% | ICU Level of Service H |
| Analysis Period (min) 15 | |

HCM Unsignalized Intersection Capacity Analysis
2: Main St/Connector to Exit 3 Ramps & Buzzards Bay Bypass/Scenic Hwy 01/17/2017

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Right Turn Channelized | | | MOYes | | | | | | | | | MOYes |
| Traffic Volume (veh/h) | 125 | 150 | 395 | 285 | 175 | 0 | 165 | 530 | 0 | 550 | 705 | 130 |
| Future Volume (veh/h) | 125 | 150 | 395 | 285 | 175 | 0 | 165 | 530 | 0 | 550 | 705 | 130 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 136 | 163 | 429 | 310 | 190 | 0 | 179 | 576 | 0 | 598 | 766 | 141 |
| Approach Volume (veh/h) | | 299 | | | 500 | | | 755 | | | 1364 | |
| Crossing Volume (veh/h) | | 1674# | | | 891 | | | 897 | | | 679 | |
| High Capacity (veh/h) | | 355 | | | 681 | | | 677 | | | 808 | |
| High v/c (veh/h) | | 0.84 | | | 0.73 | | | 1.11 | | | 1.69 | |
| Low Capacity (veh/h) | | 258 | | | 533 | | | 530 | | | 644 | |
| Low v/c (veh/h) | | 1.16 | | | 0.94 | | | 1.42 | | | 2.12 | |

| Intersection Summary | | | |
|---|---|---|---|
| Maximum v/c High | 1.69 | | |
| Maximum v/c Low | 2.12 | | |
| Intersection Capacity Utilization | 158.2% | ICU Level of Service | H |

# Crossing flow exceeds 1200, method is not applicable

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 192.2 |
| Intersection LOS | F |

| Approach | EB | WB | NE | SW |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 2 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 728 | 500 | 755 | 1505 |
| Demand Flow Rate, veh/h | 743 | 510 | 771 | 1535 |
| Vehicles Circulating, veh/h | 1707 | 910 | 915 | 693 |
| Vehicles Exiting, veh/h | 377 | 776 | 1097 | 727 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 195.1 | 109.8 | 348.3 | 139.8 |
| Approach LOS | F | F | F | F |

| Lane | Left | Bypass | Left | Left | Left | Right | Bypass |
|---|---|---|---|---|---|---|---|
| Designated Moves | LT | R | LT | LTR | L | TR | R |
| Assumed Moves | LT | R | LT | LTR | L | TR | R |
| RT Channelized | | Yield | | | | | Yield |
| Lane Util | 1.000 | | 1.000 | 1.000 | 0.439 | 0.561 | |
| Critical Headway, s | 5.193 | | 5.193 | 5.193 | 5.193 | 5.193 | |
| Entry Flow, veh/h | 305 | 438 | 510 | 771 | 610 | 781 | 144 |
| Cap Entry Lane, veh/h | 205 | 377 | 455 | 453 | 565 | 565 | 775 |
| Entry HV Adj Factor | 0.979 | 0.980 | 0.981 | 0.980 | 0.980 | 0.980 | 0.980 |
| Flow Entry, veh/h | 299 | 429 | 500 | 755 | 598 | 766 | 141 |
| Cap Entry, veh/h | 201 | 370 | 446 | 443 | 554 | 554 | 760 |
| V/C Ratio | 1.488 | 1.160 | 1.121 | 1.704 | 1.080 | 1.382 | 0.186 |
| Control Delay, s/veh | 287.8 | 130.6 | 109.8 | 348.3 | 88.4 | 204.4 | 6.7 |
| LOS | F | F | F | F | F | F | A |
| 95th %tile Queue, veh | 18 | 17 | 17 | 45 | 18 | 35 | 1 |

# Bourne Rotary

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 340 | 30 | 50 | 95 | 25 | 20 |
| Future Volume (vph) | 340 | 30 | 50 | 95 | 25 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.989 | | | | 0.939 | |
| Flt Protected | | | | 0.983 | 0.973 | |
| Satd. Flow (prot) | 1790 | 0 | 0 | 1779 | 1653 | 0 |
| Flt Permitted | | | | 0.983 | 0.973 | |
| Satd. Flow (perm) | 1790 | 0 | 0 | 1779 | 1653 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1631 | 761 | |
| Travel Time (s) | 37.8 | | | 37.1 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 370 | 33 | 54 | 103 | 27 | 22 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 403 | 0 | 0 | 157 | 49 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 40.8% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 340 | 30 | 50 | 95 | 25 | 20 |
| Future Volume (Veh/h) | 340 | 30 | 50 | 95 | 25 | 20 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 370 | 33 | 54 | 103 | 27 | 22 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 403 | | 598 | 386 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 403 | | 598 | 386 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 95 | | 94 | 97 |
| cM capacity (veh/h) | | | 1140 | | 439 | 655 |

| Direction, Lane # | EB 1 | WB 1 | NW 1 |
|---|---|---|---|
| Volume Total | 403 | 157 | 49 |
| Volume Left | 0 | 54 | 27 |
| Volume Right | 33 | 0 | 22 |
| cSH | 1700 | 1140 | 515 |
| Volume to Capacity | 0.24 | 0.05 | 0.10 |
| Queue Length 95th (ft) | 0 | 4 | 8 |
| Control Delay (s) | 0.0 | 3.1 | 12.7 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 3.1 | 12.7 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.8 | | |
| Intersection Capacity Utilization | 40.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.8 |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 340 | 30 | 50 | 95 | 25 | 20 |
| Future Vol, veh/h | 340 | 30 | 50 | 95 | 25 | 20 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 370 | 33 | 54 | 103 | 27 | 22 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 402 | 0 | 598 | 386 |
| Stage 1 | - | - | - | - | 386 | - |
| Stage 2 | - | - | - | - | 212 | - |
| Critical Hdwy | - | - | 4.15 | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | - | - | 2.245 | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1141 | - | 460 | 655 |
| Stage 1 | - | - | - | - | 681 | - |
| Stage 2 | - | - | - | - | 816 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1141 | - | 437 | 655 |
| Mov Cap-2 Maneuver | - | - | - | - | 437 | - |
| Stage 1 | - | - | - | - | 681 | - |
| Stage 2 | - | - | - | - | 775 | - |

| Approach | EB | WB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 2.9 | 12.8 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NWLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | 513 | - | - | 1141 | - |
| HCM Lane V/C Ratio | 0.095 | - | - | 0.048 | - |
| HCM Control Delay (s) | 12.8 | - | - | 8.3 | 0 |
| HCM Lane LOS | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | 0.1 | - |

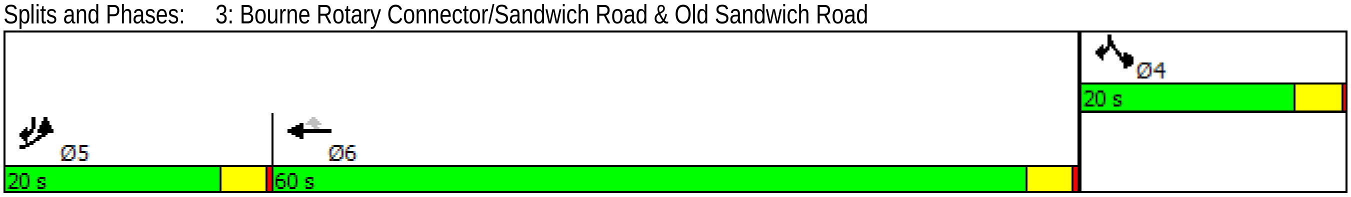
| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 1125 | 970 | 135 | 195 | 165 |
| Future Volume (vph) | 10 | 1125 | 970 | 135 | 195 | 165 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 200 | | | 400 | 0 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.950 | | | | 0.950 | |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 147 | | 94 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 1223 | 1054 | 147 | 212 | 179 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 11 | 1223 | 1054 | 147 | 212 | 179 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 5 | | 6 | 6 | 4 | 4 5 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Minimum Split (s) | 20.0 | | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | | 60.0 | 60.0 | 20.0 | |
| Total Split (%) | 20.0% | | 60.0% | 60.0% | 20.0% | |
| Maximum Green (s) | 16.0 | | 56.0 | 56.0 | 16.0 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | -1.0 | | -1.0 | -1.0 | -1.0 | |
| Total Lost Time (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | | Min | Min | None | |
| Walk Time (s) | | | 5.0 | 5.0 | | |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | | |
| Pedestrian Calls (#/hr) | | | 15 | 15 | | |
| Act Effct Green (s) | 7.2 | 88.7 | 57.0 | 57.0 | 15.5 | 25.7 |
| Actuated g/C Ratio | 0.08 | 1.00 | 0.64 | 0.64 | 0.17 | 0.29 |
| v/c Ratio | 0.08 | 0.68 | 0.91 | 0.14 | 0.71 | 0.35 |
| Control Delay | 39.6 | 2.0 | 27.4 | 1.6 | 48.4 | 14.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 39.6 | 2.0 | 27.4 | 1.6 | 48.4 | 14.1 |
| LOS | D | A | C | A | D | B |
| Approach Delay | | 2.4 | 24.3 | | 32.7 | |
| Approach LOS | | A | C | | C | |

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 88.7
Natural Cycle: 100
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 15.9 Intersection LOS: B
Intersection Capacity Utilization 76.7% ICU Level of Service D
Analysis Period (min) 15
! Phase conflict between lane groups.

Splits and Phases: 3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



Queues
3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road 01/18/2017

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 11 | 1223 | 1054 | 147 | 212 | 179 |
| v/c Ratio | 0.08 | 0.68 | 0.91 | 0.14 | 0.71 | 0.35 |
| Control Delay | 39.6 | 2.0 | 27.4 | 1.6 | 48.4 | 14.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 39.6 | 2.0 | 27.4 | 1.6 | 48.4 | 14.1 |
| Queue Length 50th (ft) | 6 | 0 | 474 | 0 | 113 | 36 |
| Queue Length 95th (ft) | 23 | 0 | #833 | 21 | #196 | 88 |
| Internal Link Dist (ft) | | 832 | 886 | | 84 | |
| Turn Bay Length (ft) | 200 | | | 400 | | |
| Base Capacity (vph) | 329 | 1810 | 1163 | 1041 | 329 | 668 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.03 | 0.68 | 0.91 | 0.14 | 0.64 | 0.27 |

Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road 01/18/2017

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 1125 | 970 | 135 | 195 | 165 |
| Future Volume (vph) | 10 | 1125 | 970 | 135 | 195 | 165 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 1223 | 1054 | 147 | 212 | 179 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 52 | 0 | 67 |
| Lane Group Flow (vph) | 11 | 1223 | 1054 | 95 | 212 | 112 |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |
| Actuated Green, G (s) | 6.2 | 88.8 | 56.1 | 56.1 | 14.5 | 24.7 |
| Effective Green, g (s) | 7.2 | 88.8 | 57.1 | 57.1 | 15.5 | 25.7 |
| Actuated g/C Ratio | 0.08 | 1.00 | 0.64 | 0.64 | 0.17 | 0.29 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 139 | 1810 | 1163 | 988 | 300 | 445 |
| v/s Ratio Prot | 0.01 | 0.68 | c0.58 | | 0.12 | 0.07 |
| v/s Ratio Perm | | | | 0.06 | | |
| v/c Ratio | 0.08 | 0.68 | 0.91 | 0.10 | 0.71 | 0.25 |
| Uniform Delay, d1 | 37.7 | 0.0 | 13.6 | 6.0 | 34.5 | 24.2 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 2.0 | 10.1 | 0.0 | 7.4 | 0.3 |
| Delay (s) | 38.0 | 2.0 | 23.7 | 6.1 | 41.9 | 24.5 |
| Level of Service | D | A | C | A | D | C |
| Approach Delay (s) | | 2.4 | 21.5 | | 33.9 | |
| Approach LOS | | A | C | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.9 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 88.8 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 76.7% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

! Phase conflict between lane groups.
c Critical Lane Group

HCM 2010 analysis cannot be performed with phasing conflicts.

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Volume (vph) | 20 | 535 | 380 | 25 | 55 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.992 | | 0.958 | |
| Flt Protected | | 0.998 | | | 0.967 | |
| Satd. Flow (prot) | 0 | 1806 | 1795 | 0 | 1676 | 0 |
| Flt Permitted | | 0.998 | | | 0.967 | |
| Satd. Flow (perm) | 0 | 1806 | 1795 | 0 | 1676 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 582 | 413 | 27 | 60 | 27 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 604 | 440 | 0 | 87 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 55.6% | ICU Level of Service B |
| Analysis Period (min) 15 | |

HCM Unsignalized Intersection Capacity Analysis
7: Trowbridge Road & Veteran's Way
01/18/2017

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Volume (Veh/h) | 20 | 535 | 380 | 25 | 55 | 25 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 22 | 582 | 413 | 27 | 60 | 27 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 440 | | | | 1052 | 426 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 440 | | | | 1052 | 426 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 98 | | | | 75 | 96 |
| cM capacity (veh/h) | 1104 | | | | 243 | 622 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 |
|---|---|---|---|
| Volume Total | 604 | 440 | 87 |
| Volume Left | 22 | 0 | 60 |
| Volume Right | 0 | 27 | 27 |
| cSH | 1104 | 1700 | 299 |
| Volume to Capacity | 0.02 | 0.26 | 0.29 |
| Queue Length 95th (ft) | 2 | 0 | 29 |
| Control Delay (s) | 0.5 | 0.0 | 21.9 |
| Lane LOS | A | | C |
| Approach Delay (s) | 0.5 | 0.0 | 21.9 |
| Approach LOS | | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 55.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.9 |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Vol, veh/h | 20 | 535 | 380 | 25 | 55 | 25 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 22 | 582 | 413 | 27 | 60 | 27 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 440 | 0 | - | 0 | 1052 | 427 |
| Stage 1 | - | - | - | - | 427 | - |
| Stage 2 | - | - | - | - | 625 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 1104 | - | - | - | 248 | 621 |
| Stage 1 | - | - | - | - | 652 | - |
| Stage 2 | - | - | - | - | 528 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1104 | - | - | - | 241 | 621 |
| Mov Cap-2 Maneuver | - | - | - | - | 241 | - |
| Stage 1 | - | - | - | - | 652 | - |
| Stage 2 | - | - | - | - | 513 | - |

| Approach | EB | WB | SE |
|---|---|---|---|
| HCM Control Delay, s | 0.3 | 0 | 22 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SELn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1104 | - | - | - | 298 |
| HCM Lane V/C Ratio | 0.02 | - | - | - | 0.292 |
| HCM Control Delay (s) | 8.3 | - | - | - | 22 |
| HCM Lane LOS | A | - | - | - | C |
| HCM 95th %tile Q(veh) | 0.1 | - | - | - | 1.2 |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 425 | 970 | 135 | 0 | 165 |
| Future Volume (vph) | 10 | 425 | 970 | 135 | 0 | 165 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.983 | | | 0.865 |
| Flt Protected | | 0.999 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 1779 | 0 | 0 | 1565 |
| Flt Permitted | | 0.999 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 1779 | 0 | 0 | 1565 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 462 | 1054 | 147 | 0 | 179 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 473 | 1201 | 0 | 0 | 179 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 0 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 76.1% | ICU Level of Service D |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 10 | 425 | 970 | 135 | 0 | 165 |
| Future Volume (Veh/h) | 10 | 425 | 970 | 135 | 0 | 165 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 11 | 462 | 1054 | 147 | 0 | 179 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1054 | | | | 1612 | 1128 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1054 | | | | 1612 | 1128 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 98 | | | | 100 | 27 |
| cM capacity (veh/h) | 649 | | | | 111 | 245 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 473 | 1201 | 179 |
| Volume Left | 11 | 0 | 0 |
| Volume Right | 0 | 147 | 179 |
| cSH | 649 | 1700 | 245 |
| Volume to Capacity | 0.02 | 0.71 | 0.73 |
| Queue Length 95th (ft) | 1 | 0 | 126 |
| Control Delay (s) | 0.5 | 0.0 | 51.2 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.5 | 0.0 | 51.2 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.1 | | |
| Intersection Capacity Utilization | 76.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4.4 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 10 | 425 | 970 | 135 | 0 | 165 |
| Future Vol, veh/h | 10 | 425 | 970 | 135 | 0 | 165 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 11 | 462 | 1054 | 147 | 0 | 179 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 1054 | 0 | - | 0 | - | 1054 |
| Stage 1 | - | - | - | - | - | - |
| Stage 2 | - | - | - | - | - | - |
| Critical Hdwy | 4.15 | - | - | - | - | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - |
| Follow-up Hdwy | 2.245 | - | - | - | - | 3.345 |
| Pot Cap-1 Maneuver | 649 | - | - | 0 | 0 | 271 |
| Stage 1 | - | - | - | 0 | 0 | - |
| Stage 2 | - | - | - | 0 | 0 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 649 | - | - | - | - | 271 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - |
| Stage 1 | - | - | - | - | - | - |
| Stage 2 | - | - | - | - | - | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0.2 | 0 | 40.9 |
| HCM LOS | | | E |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | SBLn1 |
|---|---|---|---|---|
| Capacity (veh/h) | 649 | - | - | 271 |
| HCM Lane V/C Ratio | 0.017 | - | - | 0.662 |
| HCM Control Delay (s) | 10.6 | 0 | - | 40.9 |
| HCM Lane LOS | B | A | - | E |
| HCM 95th %tile Q(veh) | 0.1 | - | - | 4.3 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 340 | 55 | 25 | 120 | 25 | 20 |
| Future Volume (vph) | 340 | 55 | 25 | 120 | 25 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.981 | | | | 0.939 | |
| Flt Protected | | | | 0.991 | 0.973 | |
| Satd. Flow (prot) | 1775 | 0 | 0 | 1793 | 1653 | 0 |
| Flt Permitted | | | | 0.991 | 0.973 | |
| Satd. Flow (perm) | 1775 | 0 | 0 | 1793 | 1653 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1631 | 761 | |
| Travel Time (s) | 37.8 | | | 37.1 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 370 | 60 | 27 | 130 | 27 | 22 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 430 | 0 | 0 | 157 | 49 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 37.7% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 340 | 55 | 25 | 120 | 25 | 20 |
| Future Volume (Veh/h) | 340 | 55 | 25 | 120 | 25 | 20 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 370 | 60 | 27 | 130 | 27 | 22 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 430 | | 584 | 400 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 430 | | 584 | 400 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 98 | | 94 | 97 |
| cM capacity (veh/h) | | | 1114 | | 458 | 643 |

| Direction, Lane # | EB 1 | WB 1 | NW 1 |
|---|---|---|---|
| Volume Total | 430 | 157 | 49 |
| Volume Left | 0 | 27 | 27 |
| Volume Right | 60 | 0 | 22 |
| cSH | 1700 | 1114 | 526 |
| Volume to Capacity | 0.25 | 0.02 | 0.09 |
| Queue Length 95th (ft) | 0 | 2 | 8 |
| Control Delay (s) | 0.0 | 1.6 | 12.5 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 1.6 | 12.5 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.4 | | |
| Intersection Capacity Utilization | 37.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.3 |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 340 | 55 | 25 | 120 | 25 | 20 |
| Future Vol, veh/h | 340 | 55 | 25 | 120 | 25 | 20 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 370 | 60 | 27 | 130 | 27 | 22 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 429 | 0 | 584 | 399 |
| Stage 1 | - | - | - | - | 399 | - |
| Stage 2 | - | - | - | - | 185 | - |
| Critical Hdwy | - | - | 4.15 | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | - | - | 2.245 | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1115 | - | 469 | 644 |
| Stage 1 | - | - | - | - | 671 | - |
| Stage 2 | - | - | - | - | 839 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1115 | - | 457 | 644 |
| Mov Cap-2 Maneuver | - | - | - | - | 457 | - |
| Stage 1 | - | - | - | - | 671 | - |
| Stage 2 | - | - | - | - | 817 | - |

| Approach | EB | WB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.4 | 12.6 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NWLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | 525 | - | - | 1115 | - |
| HCM Lane V/C Ratio | 0.093 | - | - | 0.024 | - |
| HCM Control Delay (s) | 12.6 | - | - | 8.3 | 0 |
| HCM Lane LOS | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | 0.1 | - |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Volume (vph) | 20 | 535 | 380 | 25 | 55 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.992 | | 0.958 | |
| Flt Protected | | 0.998 | | | 0.967 | |
| Satd. Flow (prot) | 0 | 1806 | 1795 | 0 | 1676 | 0 |
| Flt Permitted | | 0.998 | | | 0.967 | |
| Satd. Flow (perm) | 0 | 1806 | 1795 | 0 | 1676 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 582 | 413 | 27 | 60 | 27 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 604 | 440 | 0 | 87 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 55.6% | ICU Level of Service B |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Volume (Veh/h) | 20 | 535 | 380 | 25 | 55 | 25 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 22 | 582 | 413 | 27 | 60 | 27 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 440 | | | | 1052 | 426 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 440 | | | | 1052 | 426 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 98 | | | | 75 | 96 |
| cM capacity (veh/h) | 1104 | | | | 243 | 622 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 |
|---|---|---|---|
| Volume Total | 604 | 440 | 87 |
| Volume Left | 22 | 0 | 60 |
| Volume Right | 0 | 27 | 27 |
| cSH | 1104 | 1700 | 299 |
| Volume to Capacity | 0.02 | 0.26 | 0.29 |
| Queue Length 95th (ft) | 2 | 0 | 29 |
| Control Delay (s) | 0.5 | 0.0 | 21.9 |
| Lane LOS | A | | C |
| Approach Delay (s) | 0.5 | 0.0 | 21.9 |
| Approach LOS | | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 55.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

## HCM 2010 TWSC
## 7: Trowbridge Road/Trowbridge Rd & Veteran's Way 01/18/2017

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.9 |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 20 | 535 | 380 | 25 | 55 | 25 |
| Future Vol, veh/h | 20 | 535 | 380 | 25 | 55 | 25 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 22 | 582 | 413 | 27 | 60 | 27 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 440 | 0 | - | 0 | 1052 | 427 |
| Stage 1 | - | - | - | - | 427 | - |
| Stage 2 | - | - | - | - | 625 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 1104 | - | - | - | 248 | 621 |
| Stage 1 | - | - | - | - | 652 | - |
| Stage 2 | - | - | - | - | 528 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1104 | - | - | - | 241 | 621 |
| Mov Cap-2 Maneuver | - | - | - | - | 241 | - |
| Stage 1 | - | - | - | - | 652 | - |
| Stage 2 | - | - | - | - | 513 | - |

| Approach | EB | WB | SE |
|---|---|---|---|
| HCM Control Delay, s | 0.3 | 0 | 22 |
| HCM LOS | | | C |

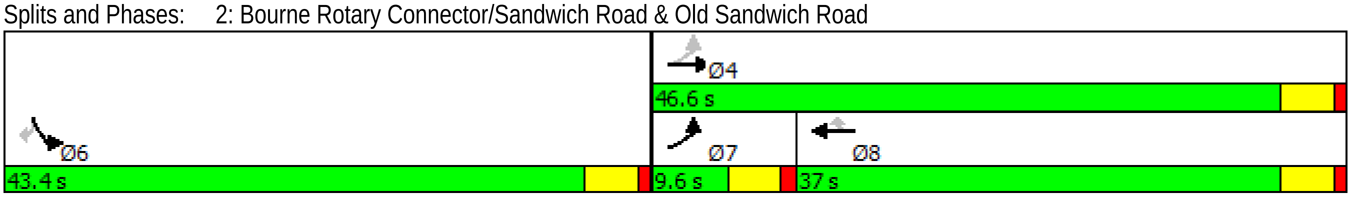
| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SELn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1104 | - | - | - | 298 |
| HCM Lane V/C Ratio | 0.02 | - | - | - | 0.292 |
| HCM Control Delay (s) | 8.3 | - | - | - | 22 |
| HCM Lane LOS | A | - | - | - | C |
| HCM 95th %tile Q(veh) | 0.1 | - | - | - | 1.2 |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 80 | 425 | 565 | 540 | 895 | 690 |
| Future Volume (vph) | 80 | 425 | 565 | 540 | 895 | 690 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 400 | | | 425 | 300 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Flt Permitted | 0.110 | | | | 0.950 | |
| Satd. Flow (perm) | 199 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 587 | | 247 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 1791 | |
| Travel Time (s) | | 20.7 | 22.0 | | 40.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 87 | 462 | 614 | 587 | 973 | 750 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 87 | 462 | 614 | 587 | 973 | 750 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | pm+pt | NA | NA | Perm | Prot | Perm |
| Protected Phases | 7 | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | 8 | 8 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 20.0 | 22.5 | 22.5 | 22.5 | 22.5 |
| Total Split (s) | 9.6 | 46.6 | 37.0 | 37.0 | 43.4 | 43.4 |
| Total Split (%) | 10.7% | 51.8% | 41.1% | 41.1% | 48.2% | 48.2% |
| Maximum Green (s) | 5.1 | 42.1 | 32.5 | 32.5 | 38.9 | 38.9 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | Min | Min | None | None |
| Walk Time (s) | | | 7.0 | 7.0 | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 41.5 | 41.5 | 31.8 | 31.8 | 37.0 | 37.0 |
| Actuated g/C Ratio | 0.47 | 0.47 | 0.36 | 0.36 | 0.42 | 0.42 |
| v/c Ratio | 0.48 | 0.54 | 0.93 | 0.63 | 0.69 | 0.95 |
| Control Delay | 22.3 | 19.6 | 51.1 | 5.3 | 23.6 | 39.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 22.3 | 19.6 | 51.1 | 5.3 | 23.6 | 39.1 |
| LOS | C | B | D | A | C | D |
| Approach Delay | | 20.0 | 28.7 | | 30.4 | |
| Approach LOS | | C | C | | C | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 90 | |
| Actuated Cycle Length: 87.5 | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.95 | |
| Intersection Signal Delay: 28.2 | Intersection LOS: C |
| Intersection Capacity Utilization 80.0% | ICU Level of Service D |
| Analysis Period (min) 15 | |

Splits and Phases: 2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 87 | 462 | 614 | 587 | 973 | 750 |
| v/c Ratio | 0.48 | 0.54 | 0.93 | 0.63 | 0.69 | 0.95 |
| Control Delay | 22.3 | 19.6 | 51.1 | 5.3 | 23.6 | 39.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 22.3 | 19.6 | 51.1 | 5.3 | 23.6 | 39.1 |
| Queue Length 50th (ft) | 27 | 181 | 333 | 0 | 221 | 288 |
| Queue Length 95th (ft) | 54 | 272 | #548 | 71 | 290 | #549 |
| Internal Link Dist (ft) |  | 832 | 886 |  | 1711 |  |
| Turn Bay Length (ft) | 400 |  |  | 425 | 300 |  |
| Base Capacity (vph) | 183 | 874 | 674 | 941 | 1488 | 822 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.48 | 0.53 | 0.91 | 0.62 | 0.65 | 0.91 |

Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 80 | 425 | 565 | 540 | 895 | 690 |
| Future Volume (vph) | 80 | 425 | 565 | 540 | 895 | 690 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Flt Permitted | 0.11 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 199 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 87 | 462 | 614 | 587 | 973 | 750 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 373 | 0 | 142 |
| Lane Group Flow (vph) | 87 | 462 | 614 | 214 | 973 | 608 |
| Turn Type | pm+pt | NA | NA | Perm | Prot | Perm |
| Protected Phases | 7 | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |
| Actuated Green, G (s) | 41.4 | 41.4 | 31.8 | 31.8 | 37.0 | 37.0 |
| Effective Green, g (s) | 41.4 | 41.4 | 31.8 | 31.8 | 37.0 | 37.0 |
| Actuated g/C Ratio | 0.47 | 0.47 | 0.36 | 0.36 | 0.42 | 0.42 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 182 | 857 | 658 | 559 | 1411 | 651 |
| v/s Ratio Prot | 0.03 | c0.26 | c0.34 | | 0.29 | |
| v/s Ratio Perm | 0.20 | | | 0.14 | | c0.40 |
| v/c Ratio | 0.48 | 0.54 | 0.93 | 0.38 | 0.69 | 0.93 |
| Uniform Delay, d1 | 18.0 | 16.3 | 26.8 | 20.5 | 20.5 | 24.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 2.0 | 0.7 | 20.3 | 0.4 | 1.4 | 20.4 |
| Delay (s) | 19.9 | 16.9 | 47.0 | 21.0 | 21.9 | 44.5 |
| Level of Service | B | B | D | C | C | D |
| Approach Delay (s) | | 17.4 | 34.3 | | 31.7 | |
| Approach LOS | | B | C | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 30.4 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 87.4 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 80.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 80 | 425 | 565 | 540 | 895 | 690 |
| Future Volume (veh/h) | 80 | 425 | 565 | 540 | 895 | 690 |
| Number | 7 | 4 | 8 | 18 | 1 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 87 | 462 | 614 | 0 | 973 | 750 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 200 | 842 | 650 | 552 | 1452 | 668 |
| Arrive On Green | 0.06 | 0.47 | 0.36 | 0.00 | 0.43 | 0.43 |
| Sat Flow, veh/h | 1723 | 1810 | 1810 | 1538 | 3343 | 1538 |
| Grp Volume(v), veh/h | 87 | 462 | 614 | 0 | 973 | 750 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 1810 | 1538 | 1672 | 1538 |
| Q Serve(g_s), s | 2.7 | 16.4 | 29.5 | 0.0 | 20.8 | 38.9 |
| Cycle Q Clear(g_c), s | 2.7 | 16.4 | 29.5 | 0.0 | 20.8 | 38.9 |
| Prop In Lane | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 200 | 842 | 650 | 552 | 1452 | 668 |
| V/C Ratio(X) | 0.43 | 0.55 | 0.94 | 0.00 | 0.67 | 1.12 |
| Avail Cap(c_a), veh/h | 202 | 851 | 657 | 558 | 1452 | 668 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 21.1 | 17.2 | 27.8 | 0.0 | 20.2 | 25.3 |
| Incr Delay (d2), s/veh | 1.5 | 0.7 | 22.4 | 0.0 | 1.2 | 73.7 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 1.3 | 8.3 | 18.7 | 0.0 | 9.8 | 39.6 |
| LnGrp Delay(d),s/veh | 22.6 | 17.9 | 50.3 | 0.0 | 21.4 | 99.0 |
| LnGrp LOS | C | B | D | | C | F |
| Approach Vol, veh/h | | 549 | 614 | | 1723 | |
| Approach Delay, s/veh | | 18.7 | 50.3 | | 55.2 | |
| Approach LOS | | B | D | | E | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | | | 46.2 | | 43.4 | 9.5 | 36.7 |
| Change Period (Y+Rc), s | | | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | | | 42.1 | | 38.9 | 5.1 | 32.5 |
| Max Q Clear Time (g_c+I1), s | | | | 18.4 | | 40.9 | 4.7 | 31.5 |
| Green Ext Time (p_c), s | | | | 7.9 | | 0.0 | 0.0 | 0.7 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 47.2 |
| HCM 2010 LOS | | D |

# Lanes, Volumes, Timings
## 3: Veteran's Way & Old Sandwich Road

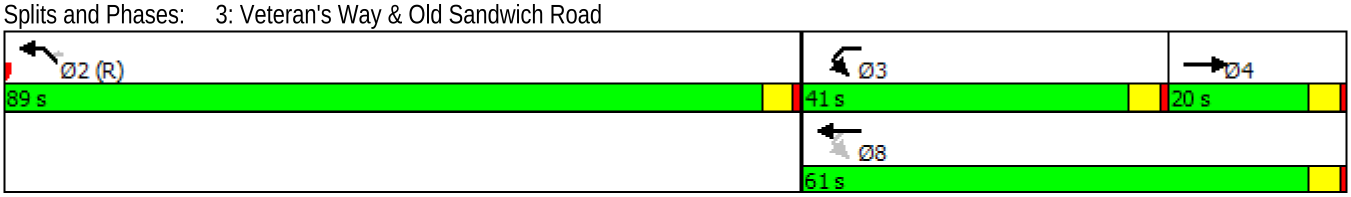
01/27/2017

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 370 | 10 | 500 | 120 | 25 | 1230 |
| Future Volume (vph) | 370 | 10 | 500 | 120 | 25 | 1230 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.996 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 3424 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.200 | | 0.950 | |
| Satd. Flow (perm) | 3424 | 0 | 362 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 1 | | | | | 767 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1791 | 761 | |
| Travel Time (s) | 37.8 | | | 40.7 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 402 | 11 | 543 | 130 | 27 | 1337 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 413 | 0 | 543 | 130 | 27 | 1337 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | | 41.0 | 61.0 | 89.0 | 89.0 |
| Total Split (%) | 13.3% | | 27.3% | 40.7% | 59.3% | 59.3% |
| Maximum Green (s) | 15.5 | | 36.5 | 56.5 | 84.5 | 84.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 15.5 | | 56.5 | 56.5 | 84.5 | 84.5 |
| Actuated g/C Ratio | 0.10 | | 0.38 | 0.38 | 0.56 | 0.56 |
| v/c Ratio | 1.17 | | 1.17 | 0.19 | 0.03 | 1.11 |
| Control Delay | 157.5 | | 135.1 | 32.4 | 14.7 | 77.9 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.1 |
| Total Delay | 157.5 | | 135.1 | 32.4 | 14.7 | 78.0 |
| LOS | F | | F | C | B | E |
| Approach Delay | 157.5 | | | 115.3 | 76.7 | |
| Approach LOS | F | | | F | E | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green | |
| Natural Cycle: 150 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 1.17 | |
| Intersection Signal Delay: 100.9 | Intersection LOS: F |
| Intersection Capacity Utilization 94.2% | ICU Level of Service F |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Veteran's Way & Old Sandwich Road



| Lane Group | EBT | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 413 | 543 | 130 | 27 | 1337 |
| v/c Ratio | 1.17 | 1.17 | 0.19 | 0.03 | 1.11 |
| Control Delay | 157.5 | 135.1 | 32.4 | 14.7 | 77.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Total Delay | 157.5 | 135.1 | 32.4 | 14.7 | 78.0 |
| Queue Length 50th (ft) | ~252 | ~580 | 85 | 11 | ~1148 |
| Queue Length 95th (ft) | #366 | #817 | 137 | 27 | #1420 |
| Internal Link Dist (ft) | 1581 | | 1711 | 681 | |
| Turn Bay Length (ft) | | 500 | | | |
| Base Capacity (vph) | 354 | 466 | 681 | 968 | 1201 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 19 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.17 | 1.17 | 0.19 | 0.03 | 1.13 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 370 | 10 | 500 | 120 | 25 | 1230 |
| Future Volume (vph) | 370 | 10 | 500 | 120 | 25 | 1230 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 3424 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.20 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 3424 | | 362 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 402 | 11 | 543 | 130 | 27 | 1337 |
| RTOR Reduction (vph) | 1 | 0 | 0 | 0 | 0 | 335 |
| Lane Group Flow (vph) | 412 | 0 | 543 | 130 | 27 | 1002 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 15.5 | | 56.5 | 56.5 | 84.5 | 84.5 |
| Effective Green, g (s) | 15.5 | | 56.5 | 56.5 | 84.5 | 84.5 |
| Actuated g/C Ratio | 0.10 | | 0.38 | 0.38 | 0.56 | 0.56 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 353 | | 466 | 681 | 968 | 866 |
| v/s Ratio Prot | 0.12 | | c0.28 | 0.07 | 0.02 | |
| v/s Ratio Perm | | | c0.16 | | | c0.65 |
| v/c Ratio | 1.17 | | 1.17 | 0.19 | 0.03 | 1.16 |
| Uniform Delay, d1 | 67.2 | | 44.9 | 31.4 | 14.5 | 32.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 101.7 | | 95.6 | 0.1 | 0.1 | 83.6 |
| Delay (s) | 168.9 | | 140.5 | 31.5 | 14.6 | 116.4 |
| Level of Service | F | | F | C | B | F |
| Approach Delay (s) | 168.9 | | | 119.5 | 114.4 | |
| Approach LOS | F | | | F | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 125.0 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.18 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 94.2% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR | | |
|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | |
| Traffic Volume (veh/h) | 370 | 10 | 500 | 120 | 25 | 1230 | | |
| Future Volume (veh/h) | 370 | 10 | 500 | 120 | 25 | 1230 | | |
| Number | 4 | 14 | 3 | 8 | 5 | 12 | | |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 | | |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 | | |
| Adj Flow Rate, veh/h | 402 | 11 | 543 | 130 | 27 | 0 | | |
| Adj No. of Lanes | 2 | 0 | 1 | 1 | 1 | 1 | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | | |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | | |
| Cap, veh/h | 353 | 10 | 467 | 682 | 971 | 866 | | |
| Arrive On Green | 0.10 | 0.10 | 0.24 | 0.38 | 0.56 | 0.00 | | |
| Sat Flow, veh/h | 3509 | 93 | 1723 | 1810 | 1723 | 1538 | | |
| Grp Volume(v), veh/h | 202 | 211 | 543 | 130 | 27 | 0 | | |
| Grp Sat Flow(s),veh/h/ln | 1719 | 1793 | 1723 | 1810 | 1723 | 1538 | | |
| Q Serve(g_s), s | 15.5 | 15.5 | 36.5 | 7.2 | 1.0 | 0.0 | | |
| Cycle Q Clear(g_c), s | 15.5 | 15.5 | 36.5 | 7.2 | 1.0 | 0.0 | | |
| Prop In Lane | | 0.05 | 1.00 | | 1.00 | 1.00 | | |
| Lane Grp Cap(c), veh/h | 178 | 185 | 467 | 682 | 971 | 866 | | |
| V/C Ratio(X) | 1.14 | 1.14 | 1.16 | 0.19 | 0.03 | 0.00 | | |
| Avail Cap(c_a), veh/h | 178 | 185 | 467 | 682 | 971 | 866 | | |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | |
| Upstream Filter(I) | 1.00 | 1.00 | 0.76 | 0.76 | 0.71 | 0.00 | | |
| Uniform Delay (d), s/veh | 67.3 | 67.3 | 45.0 | 31.4 | 14.5 | 0.0 | | |
| Incr Delay (d2), s/veh | 108.9 | 108.7 | 89.8 | 0.1 | 0.0 | 0.0 | | |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| %ile BackOfQ(50%),veh/ln | 12.7 | 13.3 | 31.0 | 3.6 | 0.5 | 0.0 | | |
| LnGrp Delay(d),s/veh | 176.1 | 175.9 | 134.9 | 31.5 | 14.6 | 0.0 | | |
| LnGrp LOS | F | F | F | C | B | | | |
| Approach Vol, veh/h | 413 | | | 673 | 27 | | | |
| Approach Delay, s/veh | 176.0 | | | 114.9 | 14.6 | | | |
| Approach LOS | F | | | F | B | | | |
| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 89.0 | 41.0 | 20.0 | | | | 61.0 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 84.5 | 36.5 | 15.5 | | | | 56.5 |
| Max Q Clear Time (g_c+I1), s | | 3.0 | 38.5 | 17.5 | | | | 9.2 |
| Green Ext Time (p_c), s | | 0.1 | 0.0 | 0.0 | | | | 3.6 |

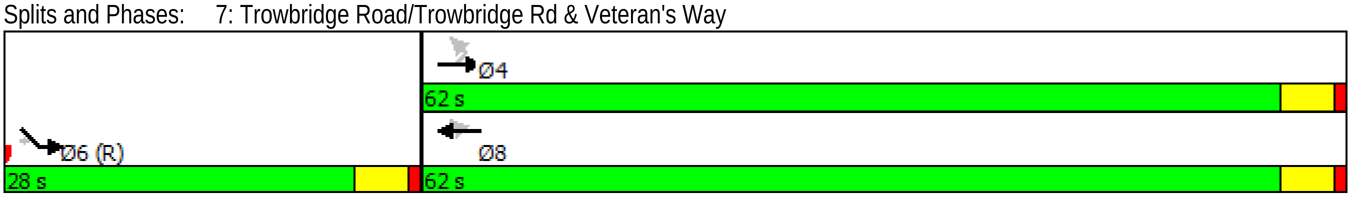
| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 135.1 |
| HCM 2010 LOS | | F |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 485 | 70 | 260 | 770 | 365 | 145 |
| Future Volume (vph) | 485 | 70 | 260 | 770 | 365 | 145 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | | 0.958 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1734 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | 0.556 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1006 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 837 | | 158 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 527 | 76 | 283 | 837 | 397 | 158 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 603 | 283 | 837 | 397 | 158 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 62.0 | 62.0 | 62.0 | 62.0 | 28.0 | 28.0 |
| Total Split (%) | 68.9% | 68.9% | 68.9% | 68.9% | 31.1% | 31.1% |
| Maximum Green (s) | 57.5 | 57.5 | 57.5 | 57.5 | 23.5 | 23.5 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | | 56.4 | 56.4 | 56.4 | 24.6 | 24.6 |
| Actuated g/C Ratio | | 0.63 | 0.63 | 0.63 | 0.27 | 0.27 |
| v/c Ratio | | 0.96 | 0.25 | 0.66 | 0.84 | 0.30 |
| Control Delay | | 44.7 | 7.9 | 3.3 | 49.9 | 6.2 |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | | 44.7 | 7.9 | 3.3 | 49.9 | 6.2 |
| LOS | | D | A | A | D | A |
| Approach Delay | | 44.7 | 4.5 | | 37.5 | |
| Approach LOS | | D | A | | D | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 90 | |
| Actuated Cycle Length: 90 | |
| Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green | |
| Natural Cycle: 90 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.96 | |
| Intersection Signal Delay: 23.2 | Intersection LOS: C |
| Intersection Capacity Utilization 85.7% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 7: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Lane Group | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 603 | 283 | 837 | 397 | 158 |
| v/c Ratio | 0.96 | 0.25 | 0.66 | 0.84 | 0.30 |
| Control Delay | 44.7 | 7.9 | 3.3 | 49.9 | 6.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 44.7 | 7.9 | 3.3 | 49.9 | 6.2 |
| Queue Length 50th (ft) | 278 | 62 | 0 | 217 | 0 |
| Queue Length 95th (ft) | #539 | 98 | 39 | #382 | 46 |
| Internal Link Dist (ft) | 1140 | 141 | | 681 | |
| Turn Bay Length (ft) | | | | | 250 |
| Base Capacity (vph) | 642 | 1156 | 1284 | 470 | 535 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.94 | 0.24 | 0.65 | 0.84 | 0.30 |

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
7: Trowbridge Road/Trowbridge Rd & Veteran's Way 01/27/2017

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 485 | 70 | 260 | 770 | 365 | 145 |
| Future Volume (vph) | 485 | 70 | 260 | 770 | 365 | 145 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1734 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | 0.56 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1006 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 527 | 76 | 283 | 837 | 397 | 158 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 312 | 0 | 115 |
| Lane Group Flow (vph) | 0 | 603 | 283 | 525 | 397 | 43 |
| Turn Type | Perm | NA | NA | Perm | Prot | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |
| Actuated Green, G (s) | | 56.4 | 56.4 | 56.4 | 24.6 | 24.6 |
| Effective Green, g (s) | | 56.4 | 56.4 | 56.4 | 24.6 | 24.6 |
| Actuated g/C Ratio | | 0.63 | 0.63 | 0.63 | 0.27 | 0.27 |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 630 | 1134 | 963 | 469 | 420 |
| v/s Ratio Prot | | | 0.16 | | c0.23 | |
| v/s Ratio Perm | | c0.60 | | 0.34 | | 0.03 |
| v/c Ratio | | 0.96 | 0.25 | 0.54 | 0.85 | 0.10 |
| Uniform Delay, d1 | | 15.7 | 7.4 | 9.5 | 30.9 | 24.4 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 25.4 | 0.1 | 0.6 | 17.0 | 0.5 |
| Delay (s) | | 41.0 | 7.6 | 10.2 | 47.9 | 24.9 |
| Level of Service | | D | A | B | D | C |
| Approach Delay (s) | | 41.0 | 9.5 | | 41.4 | |
| Approach LOS | | D | A | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 25.6 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 85.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 485 | 70 | 260 | 770 | 365 | 145 |
| Future Volume (veh/h) | 485 | 70 | 260 | 770 | 365 | 145 |
| Number | 7 | 4 | 8 | 18 | 1 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1900 | 1810 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 527 | 76 | 283 | 0 | 397 | 0 |
| Adj No. of Lanes | 0 | 1 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 620 | 79 | 1134 | 964 | 471 | 421 |
| Arrive On Green | 0.63 | 0.63 | 0.63 | 0.00 | 0.27 | 0.00 |
| Sat Flow, veh/h | 870 | 125 | 1810 | 1538 | 1723 | 1538 |
| Grp Volume(v), veh/h | 603 | 0 | 283 | 0 | 397 | 0 |
| Grp Sat Flow(s),veh/h/ln | 995 | 0 | 1810 | 1538 | 1723 | 1538 |
| Q Serve(g_s), s | 46.6 | 0.0 | 6.2 | 0.0 | 19.6 | 0.0 |
| Cycle Q Clear(g_c), s | 52.8 | 0.0 | 6.2 | 0.0 | 19.6 | 0.0 |
| Prop In Lane | 0.87 | | | 1.00 | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 698 | 0 | 1134 | 964 | 471 | 421 |
| V/C Ratio(X) | 0.86 | 0.00 | 0.25 | 0.00 | 0.84 | 0.00 |
| Avail Cap(c_a), veh/h | 712 | 0 | 1156 | 983 | 471 | 421 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 0.00 | 0.09 | 0.00 |
| Uniform Delay (d), s/veh | 19.1 | 0.0 | 7.4 | 0.0 | 30.9 | 0.0 |
| Incr Delay (d2), s/veh | 10.5 | 0.0 | 0.1 | 0.0 | 1.8 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 16.3 | 0.0 | 3.1 | 0.0 | 9.5 | 0.0 |
| LnGrp Delay(d),s/veh | 29.7 | 0.0 | 7.6 | 0.0 | 32.7 | 0.0 |
| LnGrp LOS | C | | A | | C | |
| Approach Vol, veh/h | | 603 | 283 | | 397 | |
| Approach Delay, s/veh | | 29.7 | 7.6 | | 32.7 | |
| Approach LOS | | C | A | | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | | | 4 | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | | | | 60.9 | | 29.1 | | 60.9 |
| Change Period (Y+Rc), s | | | | 4.5 | | 4.5 | | 4.5 |
| Max Green Setting (Gmax), s | | | | 57.5 | | 23.5 | | 57.5 |
| Max Q Clear Time (g_c+I1), s | | | | 54.8 | | 21.6 | | 8.2 |
| Green Ext Time (p_c), s | | | | 1.6 | | 0.3 | | 8.8 |

| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 25.7 |
| HCM 2010 LOS | C |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 175 | 25 | 25 | 140 | 15 | 20 |
| Future Volume (vph) | 175 | 25 | 25 | 140 | 15 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.983 | | | | 0.922 | |
| Flt Protected | | | | 0.993 | 0.979 | |
| Satd. Flow (prot) | 1779 | 0 | 0 | 1797 | 1633 | 0 |
| Flt Permitted | | | | 0.993 | 0.979 | |
| Satd. Flow (perm) | 1779 | 0 | 0 | 1797 | 1633 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1631 | 761 | |
| Travel Time (s) | 37.8 | | | 37.1 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 190 | 27 | 27 | 152 | 16 | 22 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 217 | 0 | 0 | 179 | 38 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 32.8% ICU Level of Service A
Analysis Period (min) 15

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 175 | 25 | 25 | 140 | 15 | 20 |
| Future Volume (Veh/h) | 175 | 25 | 25 | 140 | 15 | 20 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 190 | 27 | 27 | 152 | 16 | 22 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 217 | | 410 | 204 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 217 | | 410 | 204 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 98 | | 97 | 97 |
| cM capacity (veh/h) | | | 1335 | | 580 | 830 |

| Direction, Lane # | EB 1 | WB 1 | NW 1 |
|---|---|---|---|
| Volume Total | 217 | 179 | 38 |
| Volume Left | 0 | 27 | 16 |
| Volume Right | 27 | 0 | 22 |
| cSH | 1700 | 1335 | 703 |
| Volume to Capacity | 0.13 | 0.02 | 0.05 |
| Queue Length 95th (ft) | 0 | 2 | 4 |
| Control Delay (s) | 0.0 | 1.3 | 10.4 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 1.3 | 10.4 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.5 | | |
| Intersection Capacity Utilization | 32.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

## HCM 2010 TWSC
## 2: Veteran's Way & Old Sandwich Road

01/23/2017

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 1.4 | | | | | |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 175 | 25 | 25 | 140 | 15 | 20 |
| Future Vol, veh/h | 175 | 25 | 25 | 140 | 15 | 20 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 190 | 27 | 27 | 152 | 16 | 22 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 217 | 0 | 411 | 204 |
| Stage 1 | - | - | - | - | 204 | - |
| Stage 2 | - | - | - | - | 207 | - |
| Critical Hdwy | - | - | 4.15 | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | - | - | 2.245 | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1335 | - | 591 | 829 |
| Stage 1 | - | - | - | - | 823 | - |
| Stage 2 | - | - | - | - | 821 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1335 | - | 578 | 829 |
| Mov Cap-2 Maneuver | - | - | - | - | 578 | - |
| Stage 1 | - | - | - | - | 823 | - |
| Stage 2 | - | - | - | - | 803 | - |

| Approach | EB | WB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.2 | 10.4 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NWLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | 699 | - | - | 1335 | - |
| HCM Lane V/C Ratio | 0.054 | - | - | 0.02 | - |
| HCM Control Delay (s) | 10.4 | - | - | 7.8 | 0 |
| HCM Lane LOS | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.2 | - | - | 0.1 | - |

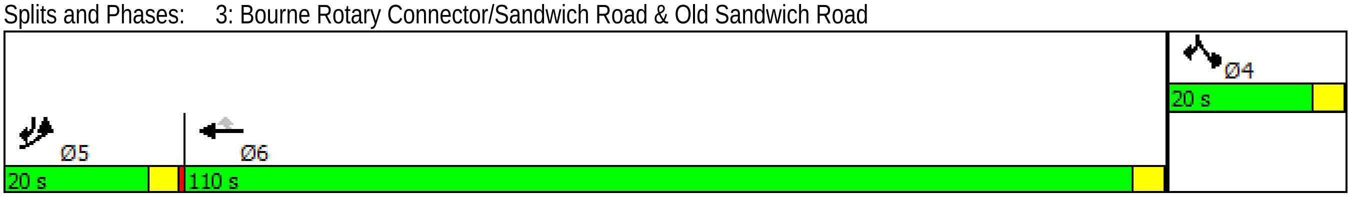
| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 1560 | 1295 | 150 | 70 | 125 |
| Future Volume (vph) | 15 | 1560 | 1295 | 150 | 70 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 200 | | | 400 | 0 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.950 | | | | 0.950 | |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 163 | | 79 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 1696 | 1408 | 163 | 76 | 136 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 16 | 1696 | 1408 | 163 | 76 | 136 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 5 | | 6 | 6 | 4 | 4 5 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Minimum Split (s) | 20.0 | | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | | 110.0 | 110.0 | 20.0 | |
| Total Split (%) | 13.3% | | 73.3% | 73.3% | 13.3% | |
| Maximum Green (s) | 16.0 | | 106.0 | 106.0 | 16.0 | |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | -1.0 | | -1.0 | -1.0 | -1.0 | |
| Total Lost Time (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Recall Mode | None | | Min | Min | None | |
| Walk Time (s) | | | 5.0 | 5.0 | | |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | | |
| Pedestrian Calls (#/hr) | | | 15 | 15 | | |
| Act Effct Green (s) | 7.9 | 136.3 | 107.1 | 107.1 | 12.3 | 23.2 |
| Actuated g/C Ratio | 0.06 | 1.00 | 0.79 | 0.79 | 0.09 | 0.17 |
| v/c Ratio | 0.16 | 0.94 | 0.99 | 0.13 | 0.49 | 0.42 |
| Control Delay | 65.9 | 11.8 | 37.2 | 0.9 | 70.0 | 25.8 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 65.9 | 11.8 | 37.2 | 0.9 | 70.0 | 25.8 |
| LOS | E | B | D | A | E | C |
| Approach Delay | | 12.3 | 33.4 | | 41.6 | |
| Approach LOS | | B | C | | D | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 150 | |
| Actuated Cycle Length: 136.3 | |
| Natural Cycle: 150 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.99 | |
| Intersection Signal Delay: 23.6 | Intersection LOS: C |
| Intersection Capacity Utilization 92.7% | ICU Level of Service F |
| Analysis Period (min) 15 | |

! Phase conflict between lane groups.

Splits and Phases: 3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



## 3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road

01/23/2017

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 16 | 1696 | 1408 | 163 | 76 | 136 |
| v/c Ratio | 0.16 | 0.94 | 0.99 | 0.13 | 0.49 | 0.42 |
| Control Delay | 65.9 | 11.8 | 37.2 | 0.9 | 70.0 | 25.8 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 65.9 | 11.8 | 37.2 | 0.9 | 70.0 | 25.8 |
| Queue Length 50th (ft) | 14 | 0 | 1014 | 0 | 65 | 44 |
| Queue Length 95th (ft) | 40 | #42 | #1674 | 17 | 120 | 108 |
| Internal Link Dist (ft) | | 832 | 886 | | 84 | |
| Turn Bay Length (ft) | 200 | | | 400 | | |
| Base Capacity (vph) | 214 | 1810 | 1422 | 1243 | 214 | 424 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.07 | 0.94 | 0.99 | 0.13 | 0.36 | 0.32 |

| Intersection Summary |
|---|
| # 95th percentile volume exceeds capacity, queue may be longer. |
| Queue shown is maximum after two cycles. |

## HCM Signalized Intersection Capacity Analysis
## 3: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road

01/23/2017

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 1560 | 1295 | 150 | 70 | 125 |
| Future Volume (vph) | 15 | 1560 | 1295 | 150 | 70 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1719 | 1810 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 1696 | 1408 | 163 | 76 | 136 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 35 | 0 | 66 |
| Lane Group Flow (vph) | 16 | 1696 | 1408 | 128 | 76 | 70 |
| Turn Type | Prot | NA | NA | Perm | Prot | pt+ov |
| Protected Phases | 5 | Free! | 6 | | 4! | 4 5 |
| Permitted Phases | | | | 6 | | |
| Actuated Green, G (s) | 6.9 | 136.3 | 106.1 | 106.1 | 11.3 | 22.2 |
| Effective Green, g (s) | 7.9 | 136.3 | 107.1 | 107.1 | 12.3 | 23.2 |
| Actuated g/C Ratio | 0.06 | 1.00 | 0.79 | 0.79 | 0.09 | 0.17 |
| Clearance Time (s) | 4.0 | | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 99 | 1810 | 1422 | 1208 | 155 | 261 |
| v/s Ratio Prot | 0.01 | 0.94 | c0.78 | | 0.04 | 0.05 |
| v/s Ratio Perm | | | | 0.08 | | |
| v/c Ratio | 0.16 | 0.94 | 0.99 | 0.11 | 0.49 | 0.27 |
| Uniform Delay, d1 | 61.1 | 0.0 | 14.1 | 3.4 | 59.0 | 49.2 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 10.7 | 21.4 | 0.0 | 2.4 | 0.6 |
| Delay (s) | 61.8 | 10.7 | 35.5 | 3.5 | 61.4 | 49.7 |
| Level of Service | E | B | D | A | E | D |
| Approach Delay (s) | | 11.2 | 32.2 | | 53.9 | |
| Approach LOS | | B | C | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 23.2 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 1.03 | | |
| Actuated Cycle Length (s) | 136.3 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 92.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

! Phase conflict between lane groups.
c Critical Lane Group

HCM 2010 analysis cannot be performed with phasing conflicts.

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Volume (vph) | 10 | 555 | 350 | 25 | 40 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.991 | | 0.972 | |
| Flt Protected | | 0.999 | | | 0.962 | |
| Satd. Flow (prot) | 0 | 1808 | 1793 | 0 | 1692 | 0 |
| Flt Permitted | | 0.999 | | | 0.962 | |
| Satd. Flow (perm) | 0 | 1808 | 1793 | 0 | 1692 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 603 | 380 | 27 | 43 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 614 | 407 | 0 | 54 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 47.2% ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
7: Trowbridge Road & Veteran's Way 01/23/2017

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Volume (Veh/h) | 10 | 555 | 350 | 25 | 40 | 10 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 11 | 603 | 380 | 27 | 43 | 11 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 407 | | | | 1018 | 394 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 407 | | | | 1018 | 394 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 83 | 98 |
| cM capacity (veh/h) | 1136 | | | | 257 | 649 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 |
|---|---|---|---|
| Volume Total | 614 | 407 | 54 |
| Volume Left | 11 | 0 | 43 |
| Volume Right | 0 | 27 | 11 |
| cSH | 1136 | 1700 | 293 |
| Volume to Capacity | 0.01 | 0.24 | 0.18 |
| Queue Length 95th (ft) | 1 | 0 | 17 |
| Control Delay (s) | 0.3 | 0.0 | 20.0 |
| Lane LOS | A | | C |
| Approach Delay (s) | 0.3 | 0.0 | 20.0 |
| Approach LOS | | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 47.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 1.1 | | | | | |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Vol, veh/h | 10 | 555 | 350 | 25 | 40 | 10 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 11 | 603 | 380 | 27 | 43 | 11 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 408 | 0 | - | 0 | 1019 | 394 |
| Stage 1 | - | - | - | - | 394 | - |
| Stage 2 | - | - | - | - | 625 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 1135 | - | - | - | 259 | 649 |
| Stage 1 | - | - | - | - | 675 | - |
| Stage 2 | - | - | - | - | 528 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1135 | - | - | - | 255 | 649 |
| Mov Cap-2 Maneuver | - | - | - | - | 255 | - |
| Stage 1 | - | - | - | - | 675 | - |
| Stage 2 | - | - | - | - | 520 | - |

| Approach | EB | WB | SE |
|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 20.3 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SELn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1135 | - | - | - | 290 |
| HCM Lane V/C Ratio | 0.01 | - | - | - | 0.187 |
| HCM Control Delay (s) | 8.2 | - | - | - | 20.3 |
| HCM Lane LOS | A | - | - | - | C |
| HCM 95th %tile Q(veh) | 0 | - | - | - | 0.7 |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 15 | 710 | 1295 | 150 | 0 | 125 |
| Future Volume (vph) | 15 | 710 | 1295 | 150 | 0 | 125 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.986 | | | 0.865 |
| Flt Protected | | 0.999 | | | | |
| Satd. Flow (prot) | 0 | 1808 | 1784 | 0 | 0 | 1565 |
| Flt Permitted | | 0.999 | | | | |
| Satd. Flow (perm) | 0 | 1808 | 1784 | 0 | 0 | 1565 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 164 | |
| Travel Time (s) | | 20.7 | 22.0 | | 3.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 772 | 1408 | 163 | 0 | 136 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 788 | 1571 | 0 | 0 | 136 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 0 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 91.7% | ICU Level of Service F |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 15 | 710 | 1295 | 150 | 0 | 125 |
| Future Volume (Veh/h) | 15 | 710 | 1295 | 150 | 0 | 125 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 16 | 772 | 1408 | 163 | 0 | 136 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1408 | | | | 2294 | 1490 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1408 | | | | 2294 | 1490 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 97 | | | | 100 | 9 |
| cM capacity (veh/h) | 475 | | | | 41 | 150 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 788 | 1571 | 136 |
| Volume Left | 16 | 0 | 0 |
| Volume Right | 0 | 163 | 136 |
| cSH | 475 | 1700 | 150 |
| Volume to Capacity | 0.03 | 0.92 | 0.91 |
| Queue Length 95th (ft) | 3 | 0 | 158 |
| Control Delay (s) | 1.0 | 0.0 | 109.7 |
| Lane LOS | A | | F |
| Approach Delay (s) | 1.0 | 0.0 | 109.7 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 6.3 | | |
| Intersection Capacity Utilization | 91.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 4.9 | | | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 15 | 710 | 1295 | 150 | 0 | 125 |
| Future Vol, veh/h | 15 | 710 | 1295 | 150 | 0 | 125 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | Free | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 16 | 772 | 1408 | 163 | 0 | 136 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 1408 | 0 | - | 0 | - | 1408 |
| Stage 1 | - | - | - | - | - | - |
| Stage 2 | - | - | - | - | - | - |
| Critical Hdwy | 4.15 | - | - | - | - | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - |
| Follow-up Hdwy | 2.245 | - | - | - | - | 3.345 |
| Pot Cap-1 Maneuver | 475 | - | - | 0 | 0 | 167 |
| Stage 1 | - | - | - | 0 | 0 | - |
| Stage 2 | - | - | - | 0 | 0 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | 475 | - | - | - | - | 167 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - |
| Stage 1 | - | - | - | - | - | - |
| Stage 2 | - | - | - | - | - | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0.3 | 0 | 82.9 |
| HCM LOS | | | F |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | SBLn1 |
|---|---|---|---|---|
| Capacity (veh/h) | 475 | - | - | 167 |
| HCM Lane V/C Ratio | 0.034 | - | - | 0.814 |
| HCM Control Delay (s) | 12.8 | 0 | - | 82.9 |
| HCM Lane LOS | B | A | - | F |
| HCM 95th %tile Q(veh) | 0.1 | - | - | 5.5 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 185 | 40 | 10 | 155 | 25 | 10 |
| Future Volume (vph) | 185 | 40 | 10 | 155 | 25 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.976 | | | | 0.961 | |
| Flt Protected | | | | 0.997 | 0.966 | |
| Satd. Flow (prot) | 1766 | 0 | 0 | 1804 | 1680 | 0 |
| Flt Permitted | | | | 0.997 | 0.966 | |
| Satd. Flow (perm) | 1766 | 0 | 0 | 1804 | 1680 | 0 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1631 | 761 | |
| Travel Time (s) | 37.8 | | | 37.1 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 201 | 43 | 11 | 168 | 27 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 244 | 0 | 0 | 179 | 38 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 0 | | | 0 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Sign Control | Free | | | Free | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 26.4% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 185 | 40 | 10 | 155 | 25 | 10 |
| Future Volume (Veh/h) | 185 | 40 | 10 | 155 | 25 | 10 |
| Sign Control | Free | | | Free | Stop | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 201 | 43 | 11 | 168 | 27 | 11 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | None | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | | | 244 | | 412 | 222 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | | | 244 | | 412 | 222 |
| tC, single (s) | | | 4.1 | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | | | 2.2 | | 3.5 | 3.3 |
| p0 queue free % | | | 99 | | 95 | 99 |
| cM capacity (veh/h) | | | 1305 | | 585 | 810 |

| Direction, Lane # | EB 1 | WB 1 | NW 1 |
|---|---|---|---|
| Volume Total | 244 | 179 | 38 |
| Volume Left | 0 | 11 | 27 |
| Volume Right | 43 | 0 | 11 |
| cSH | 1700 | 1305 | 636 |
| Volume to Capacity | 0.14 | 0.01 | 0.06 |
| Queue Length 95th (ft) | 0 | 1 | 5 |
| Control Delay (s) | 0.0 | 0.5 | 11.0 |
| Lane LOS | | A | B |
| Approach Delay (s) | 0.0 | 0.5 | 11.0 |
| Approach LOS | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.1 | | |
| Intersection Capacity Utilization | 26.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.1 |

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 185 | 40 | 10 | 155 | 25 | 10 |
| Future Vol, veh/h | 185 | 40 | 10 | 155 | 25 | 10 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 201 | 43 | 11 | 168 | 27 | 11 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 245 | 0 | 413 | 223 |
| Stage 1 | - | - | - | - | 223 | - |
| Stage 2 | - | - | - | - | 190 | - |
| Critical Hdwy | - | - | 4.15 | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | - | - | 2.245 | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1304 | - | 590 | 809 |
| Stage 1 | - | - | - | - | 807 | - |
| Stage 2 | - | - | - | - | 835 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1304 | - | 585 | 809 |
| Mov Cap-2 Maneuver | - | - | - | - | 585 | - |
| Stage 1 | - | - | - | - | 807 | - |
| Stage 2 | - | - | - | - | 827 | - |

| Approach | EB | WB | NW |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.5 | 11 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NWLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | 635 | - | - | 1304 | - |
| HCM Lane V/C Ratio | 0.06 | - | - | 0.008 | - |
| HCM Control Delay (s) | 11 | - | - | 7.8 | 0 |
| HCM Lane LOS | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.2 | - | - | 0 | - |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Volume (vph) | 10 | 555 | 350 | 25 | 40 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.991 | | 0.972 | |
| Flt Protected | | 0.999 | | | 0.962 | |
| Satd. Flow (prot) | 0 | 1808 | 1793 | 0 | 1692 | 0 |
| Flt Permitted | | 0.999 | | | 0.962 | |
| Satd. Flow (perm) | 0 | 1808 | 1793 | 0 | 1692 | 0 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 11 | 603 | 380 | 27 | 43 | 11 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 614 | 407 | 0 | 54 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Sign Control | | Free | Free | | Stop | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Control Type: Unsignalized | |
| Intersection Capacity Utilization 47.2% | ICU Level of Service A |
| Analysis Period (min) 15 | |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Volume (Veh/h) | 10 | 555 | 350 | 25 | 40 | 10 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 11 | 603 | 380 | 27 | 43 | 11 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 407 | | | | 1018 | 394 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 407 | | | | 1018 | 394 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 99 | | | | 83 | 98 |
| cM capacity (veh/h) | 1136 | | | | 257 | 649 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 |
|---|---|---|---|
| Volume Total | 614 | 407 | 54 |
| Volume Left | 11 | 0 | 43 |
| Volume Right | 0 | 27 | 11 |
| cSH | 1136 | 1700 | 293 |
| Volume to Capacity | 0.01 | 0.24 | 0.18 |
| Queue Length 95th (ft) | 1 | 0 | 17 |
| Control Delay (s) | 0.3 | 0.0 | 20.0 |
| Lane LOS | A | | C |
| Approach Delay (s) | 0.3 | 0.0 | 20.0 |
| Approach LOS | | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 47.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 1.1 | | | | | |

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 10 | 555 | 350 | 25 | 40 | 10 |
| Future Vol, veh/h | 10 | 555 | 350 | 25 | 40 | 10 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Mvmt Flow | 11 | 603 | 380 | 27 | 43 | 11 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 408 | 0 | - | 0 | 1019 | 394 |
| Stage 1 | - | - | - | - | 394 | - |
| Stage 2 | - | - | - | - | 625 | - |
| Critical Hdwy | 4.15 | - | - | - | 6.45 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.45 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.45 | - |
| Follow-up Hdwy | 2.245 | - | - | - | 3.545 | 3.345 |
| Pot Cap-1 Maneuver | 1135 | - | - | - | 259 | 649 |
| Stage 1 | - | - | - | - | 675 | - |
| Stage 2 | - | - | - | - | 528 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1135 | - | - | - | 255 | 649 |
| Mov Cap-2 Maneuver | - | - | - | - | 255 | - |
| Stage 1 | - | - | - | - | 675 | - |
| Stage 2 | - | - | - | - | 520 | - |

| Approach | EB | WB | SE |
|---|---|---|---|
| HCM Control Delay, s | 0.1 | 0 | 20.3 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SELn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1135 | - | - | - | 290 |
| HCM Lane V/C Ratio | 0.01 | - | - | - | 0.187 |
| HCM Control Delay (s) | 8.2 | - | - | - | 20.3 |
| HCM Lane LOS | A | - | - | - | C |
| HCM 95th %tile Q(veh) | 0 | - | - | - | 0.7 |

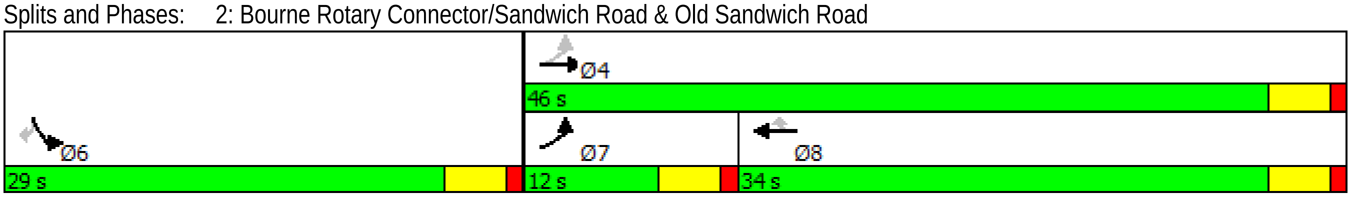
| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 215 | 710 | 605 | 810 | 875 | 475 |
| Future Volume (vph) | 215 | 710 | 605 | 810 | 875 | 475 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 400 | | | 425 | 300 | 0 |
| Storage Lanes | 1 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | 0.950 | | | | 0.950 | |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Flt Permitted | 0.118 | | | | 0.950 | |
| Satd. Flow (perm) | 214 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 871 | | 316 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 912 | 966 | | 1791 | |
| Travel Time (s) | | 20.7 | 22.0 | | 40.7 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 234 | 772 | 658 | 880 | 951 | 516 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 234 | 772 | 658 | 880 | 951 | 516 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 12 | 12 | | 24 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | pm+pt | NA | NA | Perm | Prot | Perm |
| Protected Phases | 7 | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Detector Phase | 7 | 4 | 8 | 8 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 9.5 | 20.0 | 22.5 | 22.5 | 22.5 | 22.5 |
| Total Split (s) | 12.0 | 46.0 | 34.0 | 34.0 | 29.0 | 29.0 |
| Total Split (%) | 16.0% | 61.3% | 45.3% | 45.3% | 38.7% | 38.7% |
| Maximum Green (s) | 7.5 | 41.5 | 29.5 | 29.5 | 24.5 | 24.5 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lead | | Lag | Lag | | |
| Lead-Lag Optimize? | Yes | | Yes | Yes | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | Min | Min | None | None |
| Walk Time (s) | | | 7.0 | 7.0 | 7.0 | 7.0 |
| Flash Dont Walk (s) | | | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | | | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 41.4 | 41.4 | 29.4 | 29.4 | 24.0 | 24.0 |
| Actuated g/C Ratio | 0.56 | 0.56 | 0.40 | 0.40 | 0.32 | 0.32 |
| v/c Ratio | 0.87 | 0.77 | 0.92 | 0.78 | 0.88 | 0.73 |
| Control Delay | 46.0 | 19.4 | 42.8 | 7.2 | 35.6 | 15.3 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 46.0 | 19.4 | 42.8 | 7.2 | 35.6 | 15.3 |
| LOS | D | B | D | A | D | B |
| Approach Delay | | 25.6 | 22.4 | | 28.4 | |
| Approach LOS | | C | C | | C | |

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 74.4
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 25.4 Intersection LOS: C
Intersection Capacity Utilization 80.0% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road



## Queues
## 2: Bourne Rotary Connector/Sandwich Road & Old Sandwich Road

01/27/2017

| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 234 | 772 | 658 | 880 | 951 | 516 |
| v/c Ratio | 0.87 | 0.77 | 0.92 | 0.78 | 0.88 | 0.73 |
| Control Delay | 46.0 | 19.4 | 42.8 | 7.2 | 35.6 | 15.3 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 46.0 | 19.4 | 42.8 | 7.2 | 35.6 | 15.3 |
| Queue Length 50th (ft) | 57 | 258 | 284 | 3 | 211 | 73 |
| Queue Length 95th (ft) | #182 | 409 | #492 | 90 | #319 | 192 |
| Internal Link Dist (ft) | | 832 | 886 | | 1711 | |
| Turn Bay Length (ft) | 400 | | | 425 | 300 | |
| Base Capacity (vph) | 270 | 1009 | 717 | 1135 | 1098 | 718 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.87 | 0.77 | 0.92 | 0.78 | 0.87 | 0.72 |

Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 215 | 710 | 605 | 810 | 875 | 475 |
| Future Volume (vph) | 215 | 710 | 605 | 810 | 875 | 475 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1719 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Flt Permitted | 0.12 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 214 | 1810 | 1810 | 1538 | 3335 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 234 | 772 | 658 | 880 | 951 | 516 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 527 | 0 | 214 |
| Lane Group Flow (vph) | 234 | 772 | 658 | 353 | 951 | 302 |
| Turn Type | pm+pt | NA | NA | Perm | Prot | Perm |
| Protected Phases | 7 | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |
| Actuated Green, G (s) | 41.4 | 41.4 | 29.4 | 29.4 | 24.0 | 24.0 |
| Effective Green, g (s) | 41.4 | 41.4 | 29.4 | 29.4 | 24.0 | 24.0 |
| Actuated g/C Ratio | 0.56 | 0.56 | 0.40 | 0.40 | 0.32 | 0.32 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 270 | 1007 | 715 | 607 | 1075 | 496 |
| v/s Ratio Prot | 0.09 | c0.43 | 0.36 | | c0.29 | |
| v/s Ratio Perm | c0.39 | | | 0.23 | | 0.20 |
| v/c Ratio | 0.87 | 0.77 | 0.92 | 0.58 | 0.88 | 0.61 |
| Uniform Delay, d1 | 16.1 | 12.8 | 21.4 | 17.7 | 23.9 | 21.2 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 24.0 | 3.5 | 17.1 | 1.4 | 8.9 | 2.1 |
| Delay (s) | 40.1 | 16.3 | 38.5 | 19.1 | 32.8 | 23.4 |
| Level of Service | D | B | D | B | C | C |
| Approach Delay (s) | | 21.8 | 27.4 | | 29.4 | |
| Approach LOS | | C | C | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 26.8 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 74.4 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 80.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 215 | 710 | 605 | 810 | 875 | 475 |
| Future Volume (veh/h) | 215 | 710 | 605 | 810 | 875 | 475 |
| Number | 7 | 4 | 8 | 18 | 1 | 16 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1810 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 234 | 772 | 658 | 0 | 951 | 516 |
| Adj No. of Lanes | 1 | 1 | 1 | 1 | 2 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 302 | 998 | 707 | 601 | 1097 | 504 |
| Arrive On Green | 0.10 | 0.55 | 0.39 | 0.00 | 0.33 | 0.33 |
| Sat Flow, veh/h | 1723 | 1810 | 1810 | 1538 | 3343 | 1538 |
| Grp Volume(v), veh/h | 234 | 772 | 658 | 0 | 951 | 516 |
| Grp Sat Flow(s),veh/h/ln | 1723 | 1810 | 1810 | 1538 | 1672 | 1538 |
| Q Serve(g_s), s | 5.7 | 24.9 | 26.0 | 0.0 | 20.0 | 24.5 |
| Cycle Q Clear(g_c), s | 5.7 | 24.9 | 26.0 | 0.0 | 20.0 | 24.5 |
| Prop In Lane | 1.00 | | | 1.00 | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 302 | 998 | 707 | 601 | 1097 | 504 |
| V/C Ratio(X) | 0.78 | 0.77 | 0.93 | 0.00 | 0.87 | 1.02 |
| Avail Cap(c_a), veh/h | 302 | 1005 | 715 | 607 | 1097 | 504 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 |
| Uniform Delay (d), s/veh | 16.3 | 13.1 | 21.8 | 0.0 | 23.6 | 25.1 |
| Incr Delay (d2), s/veh | 12.0 | 3.8 | 18.7 | 0.0 | 7.5 | 46.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 3.6 | 13.3 | 16.5 | 0.0 | 10.3 | 23.8 |
| LnGrp Delay(d),s/veh | 28.3 | 16.9 | 40.4 | 0.0 | 31.1 | 71.1 |
| LnGrp LOS | C | B | D | | C | F |
| Approach Vol, veh/h | | 1006 | 658 | | 1467 | |
| Approach Delay, s/veh | | 19.5 | 40.4 | | 45.2 | |
| Approach LOS | | B | D | | D | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | | | 4 | | 6 | 7 | 8 |
| Phs Duration (G+Y+Rc), s | | | | 45.7 | | 29.0 | 12.0 | 33.7 |
| Change Period (Y+Rc), s | | | | 4.5 | | 4.5 | 4.5 | 4.5 |
| Max Green Setting (Gmax), s | | | | 41.5 | | 24.5 | 7.5 | 29.5 |
| Max Q Clear Time (g_c+I1), s | | | | 26.9 | | 26.5 | 7.7 | 28.0 |
| Green Ext Time (p_c), s | | | | 8.6 | | 0.0 | 0.0 | 1.2 |

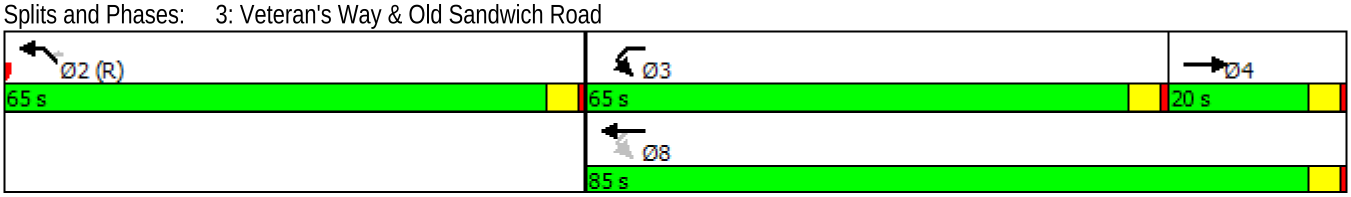
| Intersection Summary | |
|---|---|
| HCM 2010 Ctrl Delay | 35.9 |
| HCM 2010 LOS | D |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Future Volume (vph) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | | 0 | 500 | | 0 | 0 |
| Storage Lanes | | 0 | 1 | | 1 | 1 |
| Taper Length (ft) | | | 25 | | 25 | |
| Lane Util. Factor | 0.95 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.990 | | | | | 0.850 |
| Flt Protected | | | 0.950 | | 0.950 | |
| Satd. Flow (prot) | 3404 | 0 | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | | | 0.269 | | 0.950 | |
| Satd. Flow (perm) | 3404 | 0 | 487 | 1810 | 1719 | 1538 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | 4 | | | | | 880 |
| Link Speed (mph) | 30 | | | 30 | 30 | |
| Link Distance (ft) | 1661 | | | 1791 | 761 | |
| Travel Time (s) | 37.8 | | | 40.7 | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 228 | 16 | 946 | 168 | 49 | 1277 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 244 | 0 | 946 | 168 | 49 | 1277 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 12 | | | 12 | 12 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 16 | | | 16 | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | | 9 | 15 | | 15 | 9 |
| Number of Detectors | 2 | | 1 | 2 | 1 | 1 |
| Detector Template | Thru | | Left | Thru | Left | Right |
| Leading Detector (ft) | 100 | | 20 | 100 | 20 | 20 |
| Trailing Detector (ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 6 | | 20 | 6 | 20 | 20 |
| Detector 1 Type | Cl+Ex | | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 94 | | | 94 | | |
| Detector 2 Size(ft) | 6 | | | 6 | | |
| Detector 2 Type | Cl+Ex | | | Cl+Ex | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | | | 0.0 | | |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |

| Lane Group | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | | 3 | 8 | 2 | 2 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | | 9.5 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 20.0 | | 65.0 | 85.0 | 65.0 | 65.0 |
| Total Split (%) | 13.3% | | 43.3% | 56.7% | 43.3% | 43.3% |
| Maximum Green (s) | 15.5 | | 60.5 | 80.5 | 60.5 | 60.5 |
| Yellow Time (s) | 3.5 | | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | Lag | | Lead | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | 14.4 | | 79.4 | 79.4 | 61.6 | 61.6 |
| Actuated g/C Ratio | 0.10 | | 0.53 | 0.53 | 0.41 | 0.41 |
| v/c Ratio | 0.74 | | 1.25 | 0.18 | 0.07 | 1.11 |
| Control Delay | 78.6 | | 157.5 | 18.7 | 27.8 | 76.2 |
| Queue Delay | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 78.6 | | 157.5 | 18.7 | 27.8 | 76.2 |
| LOS | E | | F | B | C | E |
| Approach Delay | 78.6 | | | 136.5 | 74.4 | |
| Approach LOS | E | | | F | E | |

| Intersection Summary | |
|---|---|
| Area Type: Other | |
| Cycle Length: 150 | |
| Actuated Cycle Length: 150 | |
| Offset: 0 (0%), Referenced to phase 2:NWL and 6:, Start of Green | |
| Natural Cycle: 150 | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 1.25 | |
| Intersection Signal Delay: 100.6 | Intersection LOS: F |
| Intersection Capacity Utilization 86.5% | ICU Level of Service E |
| Analysis Period (min) 15 | |

Splits and Phases: 3: Veteran's Way & Old Sandwich Road



| Lane Group | EBT | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 244 | 946 | 168 | 49 | 1277 |
| v/c Ratio | 0.74 | 1.25 | 0.18 | 0.07 | 1.11 |
| Control Delay | 78.6 | 157.5 | 18.7 | 27.8 | 76.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 78.6 | 157.5 | 18.7 | 27.8 | 76.2 |
| Queue Length 50th (ft) | 121 | ~1087 | 82 | 29 | ~885 |
| Queue Length 95th (ft) | 171 | #1353 | 125 | 58 | #1157 |
| Internal Link Dist (ft) | 1581 | | 1711 | 681 | |
| Turn Bay Length (ft) | | 500 | | | |
| Base Capacity (vph) | 355 | 754 | 971 | 705 | 1150 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.69 | 1.25 | 0.17 | 0.07 | 1.11 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Future Volume (vph) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 0.95 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 3404 | | 1719 | 1810 | 1719 | 1538 |
| Flt Permitted | 1.00 | | 0.27 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 3404 | | 487 | 1810 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 228 | 16 | 946 | 168 | 49 | 1277 |
| RTOR Reduction (vph) | 4 | 0 | 0 | 0 | 0 | 519 |
| Lane Group Flow (vph) | 240 | 0 | 946 | 168 | 49 | 758 |
| Turn Type | NA | | pm+pt | NA | Prot | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | 8 | | | 2 |
| Actuated Green, G (s) | 14.4 | | 79.4 | 79.4 | 61.6 | 61.6 |
| Effective Green, g (s) | 14.4 | | 79.4 | 79.4 | 61.6 | 61.6 |
| Actuated g/C Ratio | 0.10 | | 0.53 | 0.53 | 0.41 | 0.41 |
| Clearance Time (s) | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 326 | | 754 | 958 | 705 | 631 |
| v/s Ratio Prot | 0.07 | | c0.51 | 0.09 | 0.03 | |
| v/s Ratio Perm | | | c0.16 | | | c0.49 |
| v/c Ratio | 0.74 | | 1.25 | 0.18 | 0.07 | 1.20 |
| Uniform Delay, d1 | 66.0 | | 36.2 | 18.3 | 26.8 | 44.2 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 8.4 | | 125.3 | 0.1 | 0.2 | 105.5 |
| Delay (s) | 74.4 | | 161.5 | 18.4 | 27.0 | 149.7 |
| Level of Service | E | | F | B | C | F |
| Approach Delay (s) | 74.4 | | | 139.9 | 145.1 | |
| Approach LOS | E | | | F | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 136.5 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.26 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 86.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBT | EBR | WBL | WBT | NWL | NWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (veh/h) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Future Volume (veh/h) | 210 | 15 | 870 | 155 | 45 | 1175 |
| Number | 4 | 14 | 3 | 8 | 5 | 12 |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 |
| Ped-Bike Adj(A_pbT) | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adj Sat Flow, veh/h/ln | 1810 | 1900 | 1810 | 1810 | 1810 | 1810 |
| Adj Flow Rate, veh/h | 228 | 16 | 946 | 168 | 49 | 0 |
| Adj No. of Lanes | 2 | 0 | 1 | 1 | 1 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 |
| Cap, veh/h | 284 | 20 | 763 | 942 | 723 | 645 |
| Arrive On Green | 0.09 | 0.09 | 0.40 | 0.52 | 0.42 | 0.00 |
| Sat Flow, veh/h | 3352 | 227 | 1723 | 1810 | 1723 | 1538 |
| Grp Volume(v), veh/h | 119 | 125 | 946 | 168 | 49 | 0 |
| Grp Sat Flow(s),veh/h/ln | 1719 | 1769 | 1723 | 1810 | 1723 | 1538 |
| Q Serve(g_s), s | 10.2 | 10.4 | 60.5 | 7.4 | 2.5 | 0.0 |
| Cycle Q Clear(g_c), s | 10.2 | 10.4 | 60.5 | 7.4 | 2.5 | 0.0 |
| Prop In Lane | | 0.13 | 1.00 | | 1.00 | 1.00 |
| Lane Grp Cap(c), veh/h | 150 | 154 | 763 | 942 | 723 | 645 |
| V/C Ratio(X) | 0.80 | 0.81 | 1.24 | 0.18 | 0.07 | 0.00 |
| Avail Cap(c_a), veh/h | 178 | 183 | 763 | 971 | 723 | 645 |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Upstream Filter(I) | 1.00 | 1.00 | 0.51 | 0.51 | 0.53 | 0.00 |
| Uniform Delay (d), s/veh | 67.2 | 67.2 | 35.4 | 19.0 | 26.0 | 0.0 |
| Incr Delay (d2), s/veh | 19.0 | 19.9 | 113.8 | 0.0 | 0.1 | 0.0 |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| %ile BackOfQ(50%),veh/ln | 5.7 | 5.9 | 55.7 | 3.7 | 1.2 | 0.0 |
| LnGrp Delay(d),s/veh | 86.2 | 87.1 | 149.2 | 19.1 | 26.1 | 0.0 |
| LnGrp LOS | F | F | F | B | C | |
| Approach Vol, veh/h | 244 | | | 1114 | 49 | |
| Approach Delay, s/veh | 86.7 | | | 129.6 | 26.1 | |
| Approach LOS | F | | | F | C | |

| Timer | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Assigned Phs | | 2 | 3 | 4 | | | | 8 |
| Phs Duration (G+Y+Rc), s | | 67.4 | 65.0 | 17.6 | | | | 82.6 |
| Change Period (Y+Rc), s | | 4.5 | 4.5 | 4.5 | | | | 4.5 |
| Max Green Setting (Gmax), s | | 60.5 | 60.5 | 15.5 | | | | 80.5 |
| Max Q Clear Time (g_c+I1), s | | 4.5 | 62.5 | 12.4 | | | | 9.4 |
| Green Ext Time (p_c), s | | 0.1 | 0.0 | 0.7 | | | | 2.7 |

| Intersection Summary | | |
|---|---|---|
| HCM 2010 Ctrl Delay | | 118.6 |
| HCM 2010 LOS | | F |

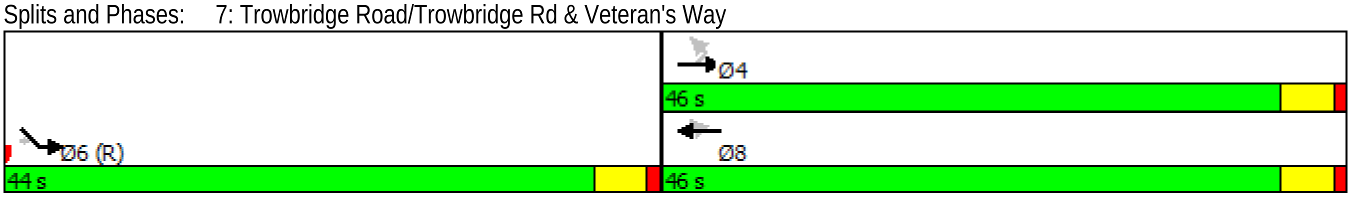
| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 335 | 230 | 165 | 885 | 690 | 195 |
| Future Volume (vph) | 335 | 230 | 165 | 885 | 690 | 195 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Storage Length (ft) | 0 | | | 0 | 0 | 250 |
| Storage Lanes | 0 | | | 1 | 1 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | | 0.850 | | 0.850 |
| Flt Protected | | 0.971 | | | 0.950 | |
| Satd. Flow (prot) | 0 | 1757 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | 0.703 | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1272 | 1810 | 1538 | 1719 | 1538 |
| Right Turn on Red | | | | Yes | | Yes |
| Satd. Flow (RTOR) | | | | 962 | | 212 |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 1220 | 221 | | 761 | |
| Travel Time (s) | | 27.7 | 5.0 | | 17.3 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 250 | 179 | 962 | 750 | 212 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 614 | 179 | 962 | 750 | 212 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Left | Right | Left | Right |
| Median Width(ft) | | 0 | 0 | | 12 | |
| Link Offset(ft) | | 0 | 0 | | 0 | |
| Crosswalk Width(ft) | | 16 | 16 | | 16 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Turning Speed (mph) | 15 | | | 9 | 15 | 9 |
| Number of Detectors | 1 | 2 | 2 | 1 | 1 | 1 |
| Detector Template | Left | Thru | Thru | Right | Left | Right |
| Leading Detector (ft) | 20 | 100 | 100 | 20 | 20 | 20 |
| Trailing Detector (ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Position(ft) | 0 | 0 | 0 | 0 | 0 | 0 |
| Detector 1 Size(ft) | 20 | 6 | 6 | 20 | 20 | 20 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | | 94 | 94 | | | |
| Detector 2 Size(ft) | | 6 | 6 | | | |
| Detector 2 Type | | Cl+Ex | Cl+Ex | | | |
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | | 0.0 | 0.0 | | | |
| Turn Type | Perm | NA | NA | Perm | Prot | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |

| Lane Group | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Detector Phase | 4 | 4 | 8 | 8 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 46.0 | 46.0 | 46.0 | 46.0 | 44.0 | 44.0 |
| Total Split (%) | 51.1% | 51.1% | 51.1% | 51.1% | 48.9% | 48.9% |
| Maximum Green (s) | 41.5 | 41.5 | 41.5 | 41.5 | 39.5 | 39.5 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Recall Mode | Min | Min | Min | Min | C-Min | C-Min |
| Act Effct Green (s) | | 41.5 | 41.5 | 41.5 | 39.5 | 39.5 |
| Actuated g/C Ratio | | 0.46 | 0.46 | 0.46 | 0.44 | 0.44 |
| v/c Ratio | | 1.05 | 0.21 | 0.78 | 0.99 | 0.27 |
| Control Delay | | 76.6 | 15.4 | 6.6 | 58.5 | 3.2 |
| Queue Delay | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | | 76.6 | 15.4 | 6.6 | 58.5 | 3.2 |
| LOS | | E | B | A | E | A |
| Approach Delay | | 76.6 | 8.0 | | 46.3 | |
| Approach LOS | | E | A | | D | |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2: and 6:SEL, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.05
Intersection Signal Delay: 37.1 Intersection LOS: D
Intersection Capacity Utilization 92.9% ICU Level of Service F
Analysis Period (min) 15

Splits and Phases: 7: Trowbridge Road/Trowbridge Rd & Veteran's Way



| Lane Group | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|
| Lane Group Flow (vph) | 614 | 179 | 962 | 750 | 212 |
| v/c Ratio | 1.05 | 0.21 | 0.78 | 0.99 | 0.27 |
| Control Delay | 76.6 | 15.4 | 6.6 | 58.5 | 3.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 76.6 | 15.4 | 6.6 | 58.5 | 3.2 |
| Queue Length 50th (ft) | ~383 | 59 | 0 | 411 | 0 |
| Queue Length 95th (ft) | #588 | 100 | 73 | #663 | 38 |
| Internal Link Dist (ft) | 1140 | 141 | | 681 | |
| Turn Bay Length (ft) | | | | | 250 |
| Base Capacity (vph) | 586 | 834 | 1227 | 754 | 793 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 1.05 | 0.21 | 0.78 | 0.99 | 0.27 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Movement | EBL | EBT | WBT | WBR | SEL | SER |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 335 | 230 | 165 | 885 | 690 | 195 |
| Future Volume (vph) | 335 | 230 | 165 | 885 | 690 | 195 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1757 | 1810 | 1538 | 1719 | 1538 |
| Flt Permitted | | 0.70 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1273 | 1810 | 1538 | 1719 | 1538 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 250 | 179 | 962 | 750 | 212 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 518 | 0 | 119 |
| Lane Group Flow (vph) | 0 | 614 | 179 | 444 | 750 | 93 |
| Turn Type | Perm | NA | NA | Perm | Prot | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | 8 | | 6 |
| Actuated Green, G (s) | | 41.5 | 41.5 | 41.5 | 39.5 | 39.5 |
| Effective Green, g (s) | | 41.5 | 41.5 | 41.5 | 39.5 | 39.5 |
| Actuated g/C Ratio | | 0.46 | 0.46 | 0.46 | 0.44 | 0.44 |
| Clearance Time (s) | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 586 | 834 | 709 | 754 | 675 |
| v/s Ratio Prot | | | 0.10 | | c0.44 | |
| v/s Ratio Perm | | c0.48 | | 0.29 | | 0.06 |
| v/c Ratio | | 1.05 | 0.21 | 0.63 | 0.99 | 0.14 |
| Uniform Delay, d1 | | 24.2 | 14.5 | 18.4 | 25.1 | 15.1 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 50.3 | 0.1 | 1.7 | 31.5 | 0.4 |
| Delay (s) | | 74.5 | 14.6 | 20.1 | 56.7 | 15.5 |
| Level of Service | | E | B | C | E | B |
| Approach Delay (s) | | 74.5 | 19.2 | | 47.6 | |
| Approach LOS | | E | B | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 41.8 | HCM 2000 Level of Service | D |
| HCM 2000 Volume to Capacity ratio | 1.02 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 92.9% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | WBT | WBR | SEL | SER | | |
|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | |
| Traffic Volume (veh/h) | 335 | 230 | 165 | 885 | 690 | 195 | | |
| Future Volume (veh/h) | 335 | 230 | 165 | 885 | 690 | 195 | | |
| Number | 7 | 4 | 8 | 18 | 1 | 16 | | |
| Initial Q (Qb), veh | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Ped-Bike Adj(A_pbT) | 1.00 | | | 1.00 | 1.00 | 1.00 | | |
| Parking Bus, Adj | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | |
| Adj Sat Flow, veh/h/ln | 1900 | 1810 | 1810 | 1810 | 1810 | 1810 | | |
| Adj Flow Rate, veh/h | 364 | 250 | 179 | 0 | 750 | 0 | | |
| Adj No. of Lanes | 0 | 1 | 1 | 1 | 1 | 1 | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | | |
| Percent Heavy Veh, % | 5 | 5 | 5 | 5 | 5 | 5 | | |
| Cap, veh/h | 389 | 223 | 834 | 709 | 756 | 675 | | |
| Arrive On Green | 0.46 | 0.46 | 0.46 | 0.00 | 0.44 | 0.00 | | |
| Sat Flow, veh/h | 705 | 484 | 1810 | 1538 | 1723 | 1538 | | |
| Grp Volume(v), veh/h | 614 | 0 | 179 | 0 | 750 | 0 | | |
| Grp Sat Flow(s),veh/h/ln | 1189 | 0 | 1810 | 1538 | 1723 | 1538 | | |
| Q Serve(g_s), s | 36.2 | 0.0 | 5.3 | 0.0 | 38.9 | 0.0 | | |
| Cycle Q Clear(g_c), s | 41.5 | 0.0 | 5.3 | 0.0 | 38.9 | 0.0 | | |
| Prop In Lane | 0.59 | | | 1.00 | 1.00 | 1.00 | | |
| Lane Grp Cap(c), veh/h | 612 | 0 | 834 | 709 | 756 | 675 | | |
| V/C Ratio(X) | 1.00 | 0.00 | 0.21 | 0.00 | 0.99 | 0.00 | | |
| Avail Cap(c_a), veh/h | 612 | 0 | 834 | 709 | 756 | 675 | | |
| HCM Platoon Ratio | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | |
| Upstream Filter(I) | 1.00 | 0.00 | 1.00 | 0.00 | 0.09 | 0.00 | | |
| Uniform Delay (d), s/veh | 28.8 | 0.0 | 14.5 | 0.0 | 25.1 | 0.0 | | |
| Incr Delay (d2), s/veh | 37.3 | 0.0 | 0.1 | 0.0 | 8.1 | 0.0 | | |
| Initial Q Delay(d3),s/veh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| %ile BackOfQ(50%),veh/ln | 21.5 | 0.0 | 2.7 | 0.0 | 20.0 | 0.0 | | |
| LnGrp Delay(d),s/veh | 66.1 | 0.0 | 14.6 | 0.0 | 33.2 | 0.0 | | |
| LnGrp LOS | F | | B | | C | | | |
| Approach Vol, veh/h | | 614 | 179 | | 750 | | | |
| Approach Delay, s/veh | | 66.1 | 14.6 | | 33.2 | | | |
| Approach LOS | | E | B | | C | | | |
| **Timer** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Assigned Phs | | | | 4 | | 6 | | 8 |
| Phs Duration (G+Y+Rc), s | | | | 46.0 | | 44.0 | | 46.0 |
| Change Period (Y+Rc), s | | | | 4.5 | | 4.5 | | 4.5 |
| Max Green Setting (Gmax), s | | | | 41.5 | | 39.5 | | 41.5 |
| Max Q Clear Time (g_c+I1), s | | | | 43.5 | | 40.9 | | 7.3 |
| Green Ext Time (p_c), s | | | | 0.0 | | 0.0 | | 6.6 |
| **Intersection Summary** | | | | | | | | |
| HCM 2010 Ctrl Delay | | | 44.1 | | | | | |
| HCM 2010 LOS | | | D | | | | | |

# Relocated Exit 1C

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 16.0 |
| Intersection LOS | C |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 1028 | 510 | 162 | 799 |
| Demand Flow Rate, veh/h | 1048 | 520 | 165 | 816 |
| Vehicles Circulating, veh/h | 365 | 875 | 1170 | 420 |
| Vehicles Exiting, veh/h | 870 | 460 | 243 | 975 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 21.2 | 14.3 | 12.5 | 11.2 |
| Approach LOS | C | B | B | B |

| Lane | Left | Right | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|---|---|
| Designated Moves | L | TR | LT | R | LT | R | LT | R |
| Assumed Moves | L | TR | LT | R | LT | R | LT | R |
| RT Channelized | | | | | | | | |
| Lane Util | 0.693 | 0.307 | 0.627 | 0.373 | 0.903 | 0.097 | 0.442 | 0.558 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 726 | 322 | 326 | 194 | 149 | 16 | 361 | 455 |
| Cap Entry Lane, veh/h | 859 | 875 | 586 | 612 | 470 | 498 | 825 | 842 |
| Entry HV Adj Factor | 0.981 | 0.981 | 0.981 | 0.979 | 0.979 | 1.000 | 0.979 | 0.980 |
| Flow Entry, veh/h | 712 | 316 | 320 | 190 | 146 | 16 | 353 | 446 |
| Cap Entry, veh/h | 843 | 858 | 575 | 600 | 460 | 498 | 807 | 825 |
| V/C Ratio | 0.845 | 0.368 | 0.556 | 0.317 | 0.317 | 0.032 | 0.438 | 0.540 |
| Control Delay, s/veh | 26.9 | 8.5 | 16.6 | 10.3 | 13.0 | 7.6 | 10.1 | 12.1 |
| LOS | D | A | C | B | B | A | B | B |
| 95th %tile Queue, veh | 10 | 2 | 3 | 1 | 1 | 0 | 2 | 3 |

| Lane Group | NBL | NBR | SET | SER | NWL | NWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | ↑↑> | | | ↑↑ |
| Traffic Volume (vph) | 0 | 0 | 325 | 410 | 0 | 880 |
| Future Volume (vph) | 0 | 0 | 325 | 410 | 0 | 880 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | 0% | | 0% | | | 0% |
| Storage Length (ft) | 0 | 0 | | 0 | 0 | |
| Storage Lanes | 0 | 0 | | 0 | 0 | |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 241 | | 270 | | | 223 |
| Travel Time (s) | 5.5 | | 6.1 | | | 5.1 |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | 0% | | 0% | | | 0% |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 799 | 0 | 0 | 957 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |

## Lanes, Volumes, Timings
## 6: Exit 1C NB Ramp & Slip Ramp to Exit 1C Ramp

12/14/2016

| Lane Group | EBL | EBT | WBT | WBR | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 945 | 375 | 0 | 0 | 410 |
| Future Volume (vph) | 0 | 945 | 375 | 0 | 0 | 410 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | 0% | | 0% | |
| Storage Length (ft) | 0 | | | 0 | 0 | 0 |
| Storage Lanes | 0 | | | 0 | 0 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 347 | 241 | | 241 | |
| Travel Time (s) | | 7.9 | 5.5 | | 5.5 | |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | | 0% | 0% | | 0% | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 1027 | 408 | 0 | 0 | 446 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |

| Lane Group | EBL | EBT | EBR | EBR2 | WBT | WBR | NBL2 | NBL | NBR | NBR2 | SEL | SET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 655 | 40 | 150 | 100 | 80 | 50 | 85 | 50 | 5 | 10 | 45 | 165 |
| Future Volume (vph) | 655 | 40 | 150 | 100 | 80 | 50 | 85 | 50 | 5 | 10 | 45 | 165 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | 0% | | | 0% | | | | 0% |
| Storage Length (ft) | 0 | | 0 | | | 0 | | 0 | 0 | | 0 | |
| Storage Lanes | 1 | | 0 | | | 0 | | 1 | 1 | | 0 | |
| Taper Length (ft) | 25 | | | | | | | 25 | | | 25 | |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | | 30 |
| Link Distance (ft) | | 241 | | | 708 | | | 406 | | | | 223 |
| Travel Time (s) | | 5.5 | | | 16.1 | | | 9.2 | | | | 5.1 |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | 0% | | | 0% | | | | 0% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 712 | 315 | 0 | 0 | 141 | 0 | 0 | 146 | 16 | 0 | 0 | 228 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |

| Lane Group | SER | NWL2 | NWL | NWT | NWR |
|---|---|---|---|---|---|
| Lane Configurations | | | | | |
| Traffic Volume (vph) | 115 | 5 | 210 | 125 | 5 |
| Future Volume (vph) | 115 | 5 | 210 | 125 | 5 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | | | 0% | |
| Storage Length (ft) | 0 | | 0 | | 0 |
| Storage Lanes | 1 | | 1 | | 0 |
| Taper Length (ft) | | | 25 | | |
| Link Speed (mph) | | | | 30 | |
| Link Distance (ft) | | | | 398 | |
| Travel Time (s) | | | | 9.0 | |
| Confl. Peds. (#/hr) | | | | | |
| Confl. Bikes (#/hr) | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | |
| Mid-Block Traffic (%) | | | | 0% | |
| Shared Lane Traffic (%) | | | | | |
| Lane Group Flow (vph) | 125 | 0 | 233 | 141 | 0 |

Intersection Summary

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 15.9 |
| Intersection LOS | C |

| Approach | EB | WB | NB | SE |
|---|---|---|---|---|
| Entry Lanes | 2 | 1 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 1027 | 141 | 162 | 353 |
| Demand Flow Rate, veh/h | 1047 | 144 | 165 | 361 |
| Vehicles Circulating, veh/h | 365 | 1252 | 1169 | 421 |
| Vehicles Exiting, veh/h | 416 | 104 | 243 | 975 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 21.2 | 12.7 | 12.4 | 7.0 |
| Approach LOS | C | B | B | A |

| Lane | Left | Right | Left | Left | Right | Left | Right |
|---|---|---|---|---|---|---|---|
| Designated Moves | L | TR | LTR | L | TR | LT | R |
| Assumed Moves | L | TR | LTR | L | TR | LT | R |
| RT Channelized | | | | | | | |
| Lane Util | 0.693 | 0.307 | 1.000 | 0.903 | 0.097 | 0.645 | 0.355 |
| Critical Headway, s | 4.293 | 4.113 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 726 | 321 | 144 | 149 | 16 | 233 | 128 |
| Cap Entry Lane, veh/h | 859 | 875 | 470 | 470 | 499 | 824 | 842 |
| Entry HV Adj Factor | 0.981 | 0.982 | 0.981 | 0.981 | 1.000 | 0.980 | 0.977 |
| Flow Entry, veh/h | 712 | 315 | 141 | 146 | 16 | 228 | 125 |
| Cap Entry, veh/h | 843 | 859 | 461 | 461 | 499 | 808 | 822 |
| V/C Ratio | 0.845 | 0.367 | 0.306 | 0.317 | 0.032 | 0.283 | 0.152 |
| Control Delay, s/veh | 26.9 | 8.4 | 12.7 | 13.0 | 7.6 | 7.6 | 5.9 |
| LOS | D | A | B | B | A | A | A |
| 95th %tile Queue, veh | 10 | 2 | 1 | 1 | 0 | 1 | 1 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | |
| Intersection LOS | |

| Approach | NW |
|---|---|
| Entry Lanes | 2 |
| Conflicting Circle Lanes | 2 |
| Adj Approach Flow, veh/h | 374 |
| Demand Flow Rate, veh/h | 382 |
| Vehicles Circulating, veh/h | 974 |
| Vehicles Exiting, veh/h | 360 |
| Follow-Up Headway, s | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 |
| Ped Cap Adj | 1.000 |
| Approach Delay, s/veh | 12.5 |
| Approach LOS | B |

| Lane | Left | Right |
|---|---|---|
| Designated Moves | L | TR |
| Assumed Moves | L | TR |
| RT Channelized | | |
| Lane Util | 0.623 | 0.377 |
| Critical Headway, s | 4.293 | 4.113 |
| Entry Flow, veh/h | 238 | 144 |
| Cap Entry Lane, veh/h | 544 | 571 |
| Entry HV Adj Factor | 0.979 | 0.981 |
| Flow Entry, veh/h | 233 | 141 |
| Cap Entry, veh/h | 533 | 561 |
| V/C Ratio | 0.437 | 0.252 |
| Control Delay, s/veh | 14.1 | 9.8 |
| LOS | B | A |
| 95th %tile Queue, veh | 2 | 1 |

Lanes, Volumes, Timings
137: Main St Connector/Tupper Rd & Route 6A 12/14/2016

| Lane Group | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 45 | 165 | 0 | 215 | 125 | 5 | 705 | 45 | 160 | 0 | 80 | 50 |
| Future Volume (vph) | 45 | 165 | 0 | 215 | 125 | 5 | 705 | 45 | 160 | 0 | 80 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 1 | | 0 | 1 | | 0 | 1 | | 0 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 306 | | | 430 | | | 137 | | | 707 | |
| Travel Time (s) | | 7.0 | | | 9.8 | | | 3.1 | | | 16.1 | |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Shared Lane Traffic (%) | | | | | | | 34% | | | | | |
| Lane Group Flow (vph) | 49 | 179 | 0 | 234 | 141 | 0 | 506 | 483 | 0 | 0 | 141 | 0 |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | | NA | |
| Protected Phases | | 6 | | | 2 | | 4 | 4 | | 3 | 3 | |
| Permitted Phases | 6 | | | 2 | | | | | | 8 | | |
| Detector Phase | 6 | 6 | | 2 | 2 | | 4 | 4 | | 3 | 3 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Minimum Split (s) | 23.5 | 23.5 | | 23.5 | 23.5 | | 23.5 | 23.5 | | 10.5 | 10.5 | |
| Total Split (s) | 30.0 | 30.0 | | 30.0 | 30.0 | | 29.0 | 29.0 | | 11.0 | 11.0 | |
| Total Split (%) | 42.9% | 42.9% | | 42.9% | 42.9% | | 41.4% | 41.4% | | 15.7% | 15.7% | |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 2.0 | 2.0 | | 2.0 | 2.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | |
| Total Lost Time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Lead/Lag | | | | | | | Lag | Lag | | Lead | Lead | |
| Lead-Lag Optimize? | | | | | | | Yes | Yes | | Yes | Yes | |
| Recall Mode | Min | Min | | None | None | | Min | Min | | None | None | |
| v/c Ratio | 0.14 | 0.35 | | 0.71 | 0.28 | | 0.80 | 0.76 | | | 0.76 | |
| Control Delay | 17.3 | 19.7 | | 32.9 | 18.3 | | 15.3 | 11.3 | | | 51.6 | |
| Queue Delay | 0.0 | 0.0 | | 72.3 | 0.0 | | 0.5 | 0.6 | | | 15.1 | |
| Total Delay | 17.3 | 19.7 | | 105.2 | 18.3 | | 15.8 | 11.9 | | | 66.7 | |
| Queue Length 50th (ft) | 14 | 54 | | 80 | 41 | | 22 | 10 | | | 41 | |
| Queue Length 95th (ft) | 36 | 99 | | 149 | 79 | | m#323 | m#65 | | | #140 | |
| Internal Link Dist (ft) | | 226 | | | 350 | | | 57 | | | 627 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 485 | 727 | | 468 | 725 | | 629 | 638 | | | 186 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 14 | 25 | | | 0 | |

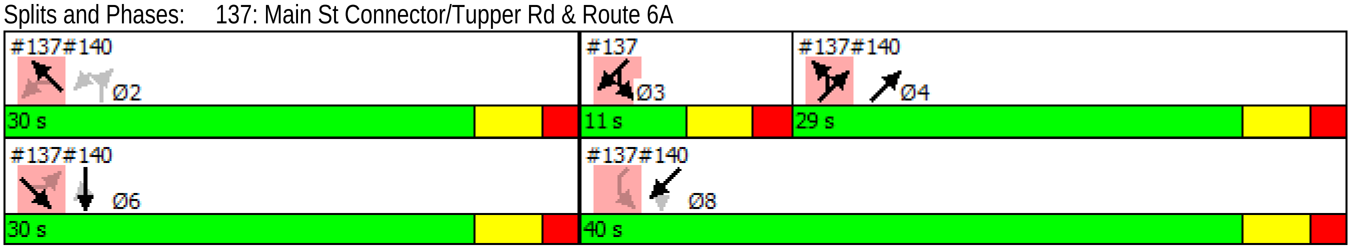
| Lane Group | Ø8 |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | |
| Future Volume (vph) | |
| Ideal Flow (vphpl) | |
| Lane Width (ft) | |
| Grade (%) | |
| Storage Length (ft) | |
| Storage Lanes | |
| Taper Length (ft) | |
| Right Turn on Red | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Confl. Peds. (#/hr) | |
| Confl. Bikes (#/hr) | |
| Peak Hour Factor | |
| Growth Factor | |
| Heavy Vehicles (%) | |
| Bus Blockages (#/hr) | |
| Parking (#/hr) | |
| Mid-Block Traffic (%) | |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | |
| Turn Type | |
| Protected Phases | 8 |
| Permitted Phases | |
| Detector Phase | |
| Switch Phase | |
| Minimum Initial (s) | 5.0 |
| Minimum Split (s) | 23.5 |
| Total Split (s) | 40.0 |
| Total Split (%) | 57% |
| Yellow Time (s) | 3.5 |
| All-Red Time (s) | 2.0 |
| Lost Time Adjust (s) | |
| Total Lost Time (s) | |
| Lead/Lag | |
| Lead-Lag Optimize? | |
| Recall Mode | None |
| v/c Ratio | |
| Control Delay | |
| Queue Delay | |
| Total Delay | |
| Queue Length 50th (ft) | |
| Queue Length 95th (ft) | |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | |
| Starvation Cap Reductn | |

| Lane Group | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | 0 | | 340 | 0 | | 0 | 0 | | | 32 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | | 0 | |
| Reduced v/c Ratio | 0.10 | 0.25 | | 1.83 | 0.19 | | 0.82 | 0.79 | | | 0.92 | |

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 63.2
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 137: Main St Connector/Tupper Rd & Route 6A



| Lane Group | Ø8 |
|---|---|
| Spillback Cap Reductn | |
| Storage Cap Reductn | |
| Reduced v/c Ratio | |

| Intersection Summary |
|---|

| Lane Group | SEL | SET | NWL | NWT | NEL | NET | SWT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 49 | 179 | 234 | 141 | 506 | 483 | 141 |
| v/c Ratio | 0.14 | 0.35 | 0.71 | 0.28 | 0.80 | 0.76 | 0.76 |
| Control Delay | 17.3 | 19.7 | 32.9 | 18.3 | 15.3 | 11.3 | 51.6 |
| Queue Delay | 0.0 | 0.0 | 72.3 | 0.0 | 0.5 | 0.6 | 15.1 |
| Total Delay | 17.3 | 19.7 | 105.2 | 18.3 | 15.8 | 11.9 | 66.7 |
| Queue Length 50th (ft) | 14 | 54 | 80 | 41 | 22 | 10 | 41 |
| Queue Length 95th (ft) | 36 | 99 | 149 | 79 | m#323 | m#65 | #140 |
| Internal Link Dist (ft) | | 226 | | 350 | | 57 | 627 |
| Turn Bay Length (ft) | | | | | | | |
| Base Capacity (vph) | 485 | 727 | 468 | 725 | 629 | 638 | 186 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 14 | 25 | 0 |
| Spillback Cap Reductn | 0 | 0 | 340 | 0 | 0 | 0 | 32 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.10 | 0.25 | 1.83 | 0.19 | 0.82 | 0.79 | 0.92 |

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis
137: Main St Connector/Tupper Rd & Route 6A 12/14/2016

| Movement | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 45 | 165 | 0 | 215 | 125 | 5 | 705 | 45 | 160 | 0 | 80 | 50 |
| Future Volume (vph) | 45 | 165 | 0 | 215 | 125 | 5 | 705 | 45 | 160 | 0 | 80 | 50 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 1.00 | | 1.00 | 0.99 | | 1.00 | 0.95 | | | 0.95 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 0.97 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 1863 | | 1770 | 1853 | | 1681 | 1630 | | | 1766 | |
| Flt Permitted | 0.67 | 1.00 | | 0.64 | 1.00 | | 0.95 | 0.97 | | | 1.00 | |
| Satd. Flow (perm) | 1243 | 1863 | | 1200 | 1853 | | 1681 | 1630 | | | 1766 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 49 | 179 | 0 | 234 | 136 | 5 | 766 | 49 | 174 | 0 | 87 | 54 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 27 | 0 | 0 | 32 | 0 |
| Lane Group Flow (vph) | 49 | 179 | 0 | 234 | 139 | 0 | 506 | 456 | 0 | 0 | 109 | 0 |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | | NA | |
| Protected Phases | | 6 | | | 2 | | 4 | 4 | | 3 | 3 | |
| Permitted Phases | 6 | | | 2 | | | | | | 8 | | |
| Actuated Green, G (s) | 17.4 | 17.4 | | 17.4 | 17.4 | | 23.8 | 23.8 | | | 5.5 | |
| Effective Green, g (s) | 17.4 | 17.4 | | 17.4 | 17.4 | | 23.8 | 23.8 | | | 5.5 | |
| Actuated g/C Ratio | 0.28 | 0.28 | | 0.28 | 0.28 | | 0.38 | 0.38 | | | 0.09 | |
| Clearance Time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 342 | 512 | | 330 | 510 | | 633 | 613 | | | 153 | |
| v/s Ratio Prot | | 0.10 | | | 0.07 | | c0.30 | 0.28 | | | c0.06 | |
| v/s Ratio Perm | 0.04 | | | c0.19 | | | | | | | | |
| v/c Ratio | 0.14 | 0.35 | | 0.71 | 0.27 | | 0.80 | 0.74 | | | 0.71 | |
| Uniform Delay, d1 | 17.3 | 18.4 | | 20.6 | 17.9 | | 17.6 | 17.1 | | | 28.1 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.24 | 0.19 | | | 1.00 | |
| Incremental Delay, d2 | 0.2 | 0.4 | | 6.8 | 0.3 | | 4.7 | 3.2 | | | 14.5 | |
| Delay (s) | 17.5 | 18.8 | | 27.4 | 18.2 | | 9.0 | 6.5 | | | 42.6 | |
| Level of Service | B | B | | C | B | | A | A | | | D | |
| Approach Delay (s) | | 18.5 | | | 24.0 | | | 7.7 | | | 42.6 | |
| Approach LOS | | B | | | C | | | A | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 15.5 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 63.2 | Sum of lost time (s) | 16.5 |
| Intersection Capacity Utilization | 71.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

| Lane Group | NBL | NBR | SET | SER | NWL | NWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 210 | 525 | 0 | 880 |
| Future Volume (vph) | 0 | 0 | 210 | 525 | 0 | 880 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | 0% | | 0% | | | 0% |
| Storage Length (ft) | 0 | 0 | | 0 | 0 | |
| Storage Lanes | 0 | 0 | | 0 | 0 | |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 301 | | 380 | | | 306 |
| Travel Time (s) | 6.8 | | 8.6 | | | 7.0 |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | 0% | | 0% | | | 0% |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 799 | 0 | 0 | 957 |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |

## Lanes, Volumes, Timings
## 140: Exit 1C NB Ramp/Main St Connector & Route 130/Main St

12/14/2016

| Lane Group | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 85 | 0 | 65 | 0 | 115 | 410 | 0 | 845 | 100 | 5 | 290 | 0 |
| Future Volume (vph) | 85 | 0 | 65 | 0 | 115 | 410 | 0 | 845 | 100 | 5 | 290 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Storage Length (ft) | 0 | | 0 | 0 | | 150 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 1 | | 1 | 0 | | 1 | 0 | | 0 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 388 | | | 301 | | | 786 | | | 137 | |
| Travel Time (s) | | 8.8 | | | 6.8 | | | 17.9 | | | 3.1 | |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 92 | 0 | 71 | 0 | 125 | 446 | 0 | 1027 | 0 | 0 | 320 | 0 |
| Turn Type | Perm | | Perm | | NA | Perm | | NA | | Perm | NA | |
| Protected Phases | | | | | 6 | | | 4 | | | 8 | |
| Permitted Phases | 2 | | 2 | | | 6 | | | | 8 | | |
| Detector Phase | 2 | | 2 | | 6 | 6 | | 4 | | 8 | 8 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | | 5.0 | 5.0 | | 5.0 | | 5.0 | 5.0 | |
| Minimum Split (s) | 23.5 | | 23.5 | | 23.5 | 23.5 | | 23.5 | | 23.5 | 23.5 | |
| Total Split (s) | 30.0 | | 30.0 | | 30.0 | 30.0 | | 29.0 | | 40.0 | 40.0 | |
| Total Split (%) | 42.9% | | 42.9% | | 42.9% | 42.9% | | 41.4% | | 57.1% | 57.1% | |
| Yellow Time (s) | 3.5 | | 3.5 | | 3.5 | 3.5 | | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 2.0 | | 2.0 | | 2.0 | 2.0 | | 2.0 | | 2.0 | 2.0 | |
| Lost Time Adjust (s) | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | | | 0.0 | |
| Total Lost Time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Lead/Lag | | | | | | | | Lag | | | | |
| Lead-Lag Optimize? | | | | | | | | Yes | | | | |
| Recall Mode | None | | None | | Min | Min | | Min | | None | None | |
| v/c Ratio | 0.27 | | 0.14 | | 0.24 | 0.59 | | 0.78 | | | 0.32 | |
| Control Delay | 19.2 | | 1.5 | | 18.3 | 5.5 | | 23.9 | | | 17.0 | |
| Queue Delay | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.1 | | | 62.7 | |
| Total Delay | 19.2 | | 1.5 | | 18.3 | 5.5 | | 24.0 | | | 79.7 | |
| Queue Length 50th (ft) | 27 | | 0 | | 37 | 0 | | 177 | | | 108 | |
| Queue Length 95th (ft) | 60 | | 8 | | 72 | 56 | | #323 | | | m221 | |
| Internal Link Dist (ft) | | 308 | | | 221 | | | 706 | | | 57 | |
| Turn Bay Length (ft) | | | | | | 150 | | | | | | |
| Base Capacity (vph) | 492 | | 694 | | 727 | 889 | | 1317 | | | 1009 | |
| Starvation Cap Reductn | 0 | | 0 | | 0 | 0 | | 0 | | | 773 | |

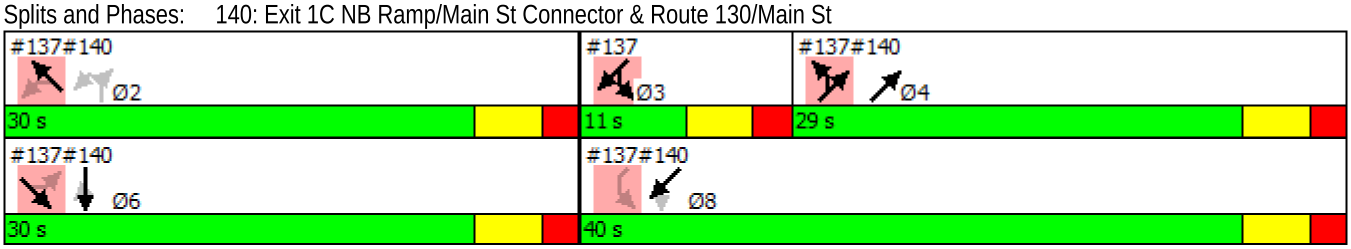
| Lane Group | Ø3 |
| --- | --- |
| Lane Configurations | |
| Traffic Volume (vph) | |
| Future Volume (vph) | |
| Ideal Flow (vphpl) | |
| Lane Width (ft) | |
| Grade (%) | |
| Storage Length (ft) | |
| Storage Lanes | |
| Taper Length (ft) | |
| Right Turn on Red | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Confl. Peds. (#/hr) | |
| Confl. Bikes (#/hr) | |
| Peak Hour Factor | |
| Growth Factor | |
| Heavy Vehicles (%) | |
| Bus Blockages (#/hr) | |
| Parking (#/hr) | |
| Mid-Block Traffic (%) | |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | |
| Turn Type | |
| Protected Phases | 3 |
| Permitted Phases | |
| Detector Phase | |
| Switch Phase | |
| Minimum Initial (s) | 5.0 |
| Minimum Split (s) | 10.5 |
| Total Split (s) | 11.0 |
| Total Split (%) | 16% |
| Yellow Time (s) | 3.5 |
| All-Red Time (s) | 2.0 |
| Lost Time Adjust (s) | |
| Total Lost Time (s) | |
| Lead/Lag | Lead |
| Lead-Lag Optimize? | Yes |
| Recall Mode | None |
| v/c Ratio | |
| Control Delay | |
| Queue Delay | |
| Total Delay | |
| Queue Length 50th (ft) | |
| Queue Length 95th (ft) | |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | |
| Starvation Cap Reductn | |

| Lane Group | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | | 75 | | 0 | 0 | | 11 | | | 0 | |
| Storage Cap Reductn | 0 | | 0 | | 0 | 0 | | 0 | | | 0 | |
| Reduced v/c Ratio | 0.19 | | 0.11 | | 0.17 | 0.50 | | 0.79 | | | 1.36 | |

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 63.2
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 140: Exit 1C NB Ramp/Main St Connector & Route 130/Main St



| Lane Group | Ø3 |
|---|---|
| Spillback Cap Reductn | |
| Storage Cap Reductn | |
| Reduced v/c Ratio | |
| Intersection Summary | |

| Lane Group | NBL | NBR | SBT | SBR | NET | SWT |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 92 | 71 | 125 | 446 | 1027 | 320 |
| v/c Ratio | 0.27 | 0.14 | 0.24 | 0.59 | 0.78 | 0.32 |
| Control Delay | 19.2 | 1.5 | 18.3 | 5.5 | 23.9 | 17.0 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 62.7 |
| Total Delay | 19.2 | 1.5 | 18.3 | 5.5 | 24.0 | 79.7 |
| Queue Length 50th (ft) | 27 | 0 | 37 | 0 | 177 | 108 |
| Queue Length 95th (ft) | 60 | 8 | 72 | 56 | #323 | m221 |
| Internal Link Dist (ft) | | | 221 | | 706 | 57 |
| Turn Bay Length (ft) | | | | 150 | | |
| Base Capacity (vph) | 492 | 694 | 727 | 889 | 1317 | 1009 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 773 |
| Spillback Cap Reductn | 0 | 75 | 0 | 0 | 11 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.19 | 0.11 | 0.17 | 0.50 | 0.79 | 1.36 |

Intersection Summary

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

| Movement | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 85 | 0 | 65 | 0 | 115 | 410 | 0 | 845 | 100 | 5 | 290 | 0 |
| Future Volume (vph) | 85 | 0 | 65 | 0 | 115 | 410 | 0 | 845 | 100 | 5 | 290 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Lane Util. Factor | 1.00 | | 1.00 | | 1.00 | 1.00 | | 0.95 | | | 1.00 | |
| Frt | 1.00 | | 0.85 | | 1.00 | 0.85 | | 0.98 | | | 1.00 | |
| Flt Protected | 0.95 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | | 1583 | | 1863 | 1583 | | 3483 | | | 1861 | |
| Flt Permitted | 0.68 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 0.99 | |
| Satd. Flow (perm) | 1261 | | 1583 | | 1863 | 1583 | | 3483 | | | 1835 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 0 | 71 | 0 | 125 | 446 | 0 | 918 | 109 | 5 | 315 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 323 | 0 | 12 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 92 | 0 | 20 | 0 | 125 | 123 | 0 | 1015 | 0 | 0 | 320 | 0 |
| Turn Type | Perm | | Perm | | NA | Perm | | NA | | Perm | NA | |
| Protected Phases | | | | | 6 | | | 4 | | | 8 | |
| Permitted Phases | 2 | | 2 | | | 6 | | | | 8 | | |
| Actuated Green, G (s) | 17.4 | | 17.4 | | 17.4 | 17.4 | | 23.8 | | | 34.8 | |
| Effective Green, g (s) | 17.4 | | 17.4 | | 17.4 | 17.4 | | 23.8 | | | 34.8 | |
| Actuated g/C Ratio | 0.28 | | 0.28 | | 0.28 | 0.28 | | 0.38 | | | 0.55 | |
| Clearance Time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | 3.0 | 3.0 | | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 347 | | 435 | | 512 | 435 | | 1311 | | | 1010 | |
| v/s Ratio Prot | | | | | 0.07 | | | c0.29 | | | | |
| v/s Ratio Perm | 0.07 | | 0.01 | | | c0.08 | | | | | c0.17 | |
| v/c Ratio | 0.27 | | 0.04 | | 0.24 | 0.28 | | 0.77 | | | 0.32 | |
| Uniform Delay, d1 | 17.9 | | 16.8 | | 17.8 | 18.0 | | 17.3 | | | 7.7 | |
| Progression Factor | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 1.75 | |
| Incremental Delay, d2 | 0.4 | | 0.0 | | 0.2 | 0.4 | | 2.9 | | | 0.2 | |
| Delay (s) | 18.3 | | 16.8 | | 18.0 | 18.4 | | 20.2 | | | 13.7 | |
| Level of Service | B | | B | | B | B | | C | | | B | |
| Approach Delay (s) | | 17.7 | | | 18.3 | | | 20.2 | | | 13.7 | |
| Approach LOS | | B | | | B | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 18.5 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 63.2 | Sum of lost time (s) | 16.5 |
| Intersection Capacity Utilization | 58.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 90.1 |
| Intersection LOS | F |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 2 | 2 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 897 | 1223 | 429 | 918 |
| Demand Flow Rate, veh/h | 915 | 1248 | 438 | 936 |
| Vehicles Circulating, veh/h | 637 | 1075 | 1242 | 948 |
| Vehicles Exiting, veh/h | 1247 | 605 | 310 | 1375 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 42.8 | 152.1 | 43.2 | 75.6 |
| Approach LOS | E | F | E | F |

| Lane | Left | Right | Left | Right | Left | Right | Left | Right |
|---|---|---|---|---|---|---|---|---|
| Designated Moves | L | TR | LT | R | LT | R | LT | R |
| Assumed Moves | L | TR | LT | R | LT | R | LT | R |
| RT Channelized | | | | | | | | |
| Lane Util | 0.751 | 0.249 | 0.564 | 0.436 | 0.886 | 0.114 | 0.669 | 0.331 |
| Critical Headway, s | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 687 | 228 | 704 | 544 | 388 | 50 | 626 | 310 |
| Cap Entry Lane, veh/h | 701 | 723 | 505 | 532 | 445 | 474 | 555 | 582 |
| Entry HV Adj Factor | 0.981 | 0.978 | 0.981 | 0.980 | 0.980 | 0.980 | 0.980 | 0.981 |
| Flow Entry, veh/h | 674 | 223 | 690 | 533 | 380 | 49 | 614 | 304 |
| Cap Entry, veh/h | 688 | 708 | 495 | 522 | 436 | 464 | 544 | 571 |
| V/C Ratio | 0.980 | 0.315 | 1.395 | 1.022 | 0.872 | 0.106 | 1.128 | 0.533 |
| Control Delay, s/veh | 54.0 | 9.0 | 212.9 | 73.3 | 47.5 | 9.2 | 105.1 | 15.9 |
| LOS | F | A | F | F | E | A | F | C |
| 95th %tile Queue, veh | 15 | 1 | 32 | 15 | 9 | 0 | 20 | 3 |

| Lane Group | NBL | NBR | SET | SER | NWL | NWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 565 | 280 | 0 | 1240 |
| Future Volume (vph) | 0 | 0 | 565 | 280 | 0 | 1240 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | 0% | | 0% | | | 0% |
| Storage Length (ft) | 0 | 0 | | 0 | 0 | |
| Storage Lanes | 0 | 0 | | 0 | 0 | |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 241 | | 270 | | | 223 |
| Travel Time (s) | 5.5 | | 6.1 | | | 5.1 |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | 0% | | 0% | | | 0% |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 918 | 0 | 0 | 1348 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |

| Lane Group | EBL | EBT | WBT | WBR | SWL | SWR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 825 | 845 | 0 | 0 | 280 |
| Future Volume (vph) | 0 | 825 | 845 | 0 | 0 | 280 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | 0% | | 0% | |
| Storage Length (ft) | 0 | | | 0 | 0 | 0 |
| Storage Lanes | 0 | | | 0 | 0 | 1 |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | | 30 | 30 | | 30 | |
| Link Distance (ft) | | 347 | 241 | | 241 | |
| Travel Time (s) | | 7.9 | 5.5 | | 5.5 | |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | | 0% | 0% | | 0% | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 897 | 918 | 0 | 0 | 304 |

| Intersection Summary | |
|---|---|
| Area Type: | Other |

| Lane Group | EBL | EBT | EBR | EBR2 | WBL2 | WBL | WBT | WBR | NBL2 | NBL | NBR | NBR2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 620 | 35 | 100 | 70 | 5 | 5 | 170 | 135 | 220 | 130 | 10 | 35 |
| Future Volume (vph) | 620 | 35 | 100 | 70 | 5 | 5 | 170 | 135 | 220 | 130 | 10 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | | | 0% | | | 0% | | |
| Storage Length (ft) | 0 | | 0 | | | 0 | | 0 | | 0 | 0 | |
| Storage Lanes | 1 | | 0 | | | 0 | | 0 | | 1 | 1 | |
| Taper Length (ft) | 25 | | | | | 25 | | | | 25 | | |
| Link Speed (mph) | | 30 | | | | | 30 | | | 30 | | |
| Link Distance (ft) | | 241 | | | | | 708 | | | 406 | | |
| Travel Time (s) | | 5.5 | | | | | 16.1 | | | 9.2 | | |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | | | 0% | | | 0% | | |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 674 | 223 | 0 | 0 | 0 | 0 | 342 | 0 | 0 | 380 | 49 | 0 |
| **Intersection Summary** | | | | | | | | | | | | |
| Area Type: | Other | | | | | | | | | | | |

| Lane Group | SEL | SET | SER | NWL2 | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | |
| Traffic Volume (vph) | 85 | 280 | 200 | 5 | 455 | 355 | 20 |
| Future Volume (vph) | 85 | 280 | 200 | 5 | 455 | 355 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | | 0% | |
| Storage Length (ft) | 0 | | 0 | | 0 | | 0 |
| Storage Lanes | 0 | | 1 | | 1 | | 0 |
| Taper Length (ft) | 25 | | | | 25 | | |
| Link Speed (mph) | | 30 | | | | 30 | |
| Link Distance (ft) | | 223 | | | | 398 | |
| Travel Time (s) | | 5.1 | | | | 9.0 | |
| Confl. Peds. (#/hr) | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | | 0% | |
| Shared Lane Traffic (%) | | | | | | | |
| Lane Group Flow (vph) | 0 | 396 | 217 | 0 | 500 | 408 | 0 |

Intersection Summary

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 63.5 |
| Intersection LOS | F |

| Approach | EB | WB | NB | SE |
|---|---|---|---|---|
| Entry Lanes | 2 | 1 | 2 | 2 |
| Conflicting Circle Lanes | 2 | 2 | 2 | 2 |
| Adj Approach Flow, veh/h | 897 | 342 | 429 | 613 |
| Demand Flow Rate, veh/h | 915 | 349 | 438 | 625 |
| Vehicles Circulating, veh/h | 640 | 1979 | 1246 | 953 |
| Vehicles Exiting, veh/h | 938 | 166 | 309 | 1375 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 43.2 | 170.6 | 43.6 | 21.2 |
| Approach LOS | E | F | E | C |

| Lane | Left | Right | Left | Left | Right | Left | Right |
|---|---|---|---|---|---|---|---|
| Designated Moves | L | TR | LTR | L | TR | LT | R |
| Assumed Moves | L | TR | LTR | L | TR | LT | R |
| RT Channelized | | | | | | | |
| Lane Util | 0.751 | 0.249 | 1.000 | 0.886 | 0.114 | 0.646 | 0.354 |
| Critical Headway, s | 4.293 | 4.113 | 4.113 | 4.293 | 4.113 | 4.293 | 4.113 |
| Entry Flow, veh/h | 687 | 228 | 349 | 388 | 50 | 404 | 221 |
| Cap Entry Lane, veh/h | 699 | 722 | 283 | 444 | 472 | 553 | 580 |
| Entry HV Adj Factor | 0.981 | 0.979 | 0.981 | 0.980 | 0.980 | 0.980 | 0.982 |
| Flow Entry, veh/h | 674 | 223 | 342 | 380 | 49 | 396 | 217 |
| Cap Entry, veh/h | 686 | 707 | 277 | 435 | 463 | 542 | 569 |
| V/C Ratio | 0.983 | 0.316 | 1.234 | 0.874 | 0.106 | 0.731 | 0.381 |
| Control Delay, s/veh | 54.6 | 9.0 | 170.6 | 48.0 | 9.2 | 26.2 | 12.1 |
| LOS | F | A | F | E | A | D | B |
| 95th %tile Queue, veh | 15 | 1 | 16 | 9 | 0 | 6 | 2 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | |
| Intersection LOS | |

| Approach | NW |
|---|---|
| Entry Lanes | 2 |
| Conflicting Circle Lanes | 2 |
| Adj Approach Flow, veh/h | 908 |
| Demand Flow Rate, veh/h | 926 |
| Vehicles Circulating, veh/h | 1219 |
| Vehicles Exiting, veh/h | 465 |
| Follow-Up Headway, s | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 |
| Ped Cap Adj | 1.000 |
| Approach Delay, s/veh | 81.1 |
| Approach LOS | F |

| Lane | Left | Right |
|---|---|---|
| Designated Moves | L | TR |
| Assumed Moves | L | TR |
| RT Channelized | | |
| Lane Util | 0.551 | 0.449 |
| Critical Headway, s | 4.293 | 4.113 |
| Entry Flow, veh/h | 510 | 416 |
| Cap Entry Lane, veh/h | 453 | 481 |
| Entry HV Adj Factor | 0.980 | 0.981 |
| Flow Entry, veh/h | 500 | 408 |
| Cap Entry, veh/h | 444 | 472 |
| V/C Ratio | 1.126 | 0.864 |
| Control Delay, s/veh | 111.6 | 43.8 |
| LOS | F | E |
| 95th %tile Queue, veh | 18 | 9 |

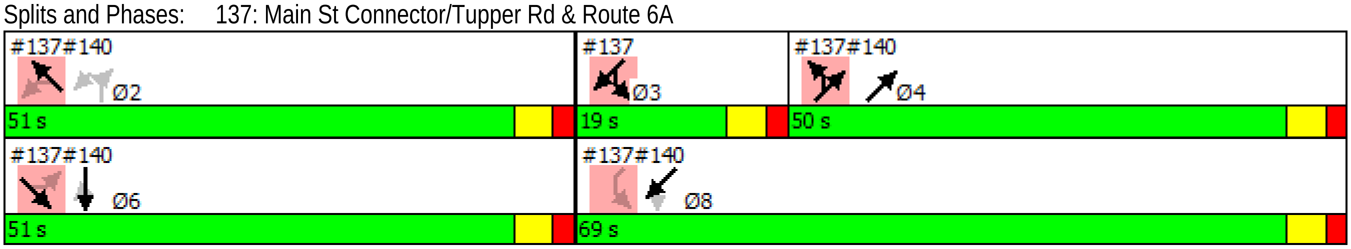
| Lane Group | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 85 | 280 | 80 | 460 | 355 | 20 | 750 | 45 | 135 | 5 | 175 | 135 |
| Future Volume (vph) | 85 | 280 | 80 | 460 | 355 | 20 | 750 | 45 | 135 | 5 | 175 | 135 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Storage Length (ft) | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 1 | | 0 | 1 | | 0 | 1 | | 0 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 306 | | | 430 | | | 137 | | | 707 | |
| Travel Time (s) | | 7.0 | | | 9.8 | | | 3.1 | | | 16.1 | |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Shared Lane Traffic (%) | | | | | | | 37% | | | | | |
| Lane Group Flow (vph) | 92 | 391 | 0 | 500 | 408 | 0 | 513 | 498 | 0 | 0 | 342 | 0 |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | custom | NA | |
| Protected Phases | | 6 | | | 2 | | 4 | 4 | | 3 | 3 | |
| Permitted Phases | 6 | | | 2 | | | | | | 8 | | |
| Detector Phase | 6 | 6 | | 2 | 2 | | 4 | 4 | | 3 | 3 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Minimum Split (s) | 23.5 | 23.5 | | 23.5 | 23.5 | | 23.5 | 23.5 | | 10.5 | 10.5 | |
| Total Split (s) | 51.0 | 51.0 | | 51.0 | 51.0 | | 50.0 | 50.0 | | 19.0 | 19.0 | |
| Total Split (%) | 42.5% | 42.5% | | 42.5% | 42.5% | | 41.7% | 41.7% | | 15.8% | 15.8% | |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | | 2.0 | 2.0 | | 2.0 | 2.0 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | |
| Total Lost Time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Lead/Lag | | | | | | | Lag | Lag | | Lead | Lead | |
| Lead-Lag Optimize? | | | | | | | Yes | Yes | | Yes | Yes | |
| Recall Mode | Min | Min | | None | None | | Min | Min | | None | None | |
| v/c Ratio | 0.39 | 0.57 | | 2.01 | 0.58 | | 0.82 | 0.80 | | | 1.56 | |
| Control Delay | 33.3 | 32.2 | | 491.8 | 33.5 | | 20.2 | 17.2 | | | 307.0 | |
| Queue Delay | 0.0 | 89.9 | | 75.3 | 0.0 | | 0.1 | 0.1 | | | 15.8 | |
| Total Delay | 33.3 | 122.1 | | 567.1 | 33.5 | | 20.2 | 17.4 | | | 322.8 | |
| Queue Length 50th (ft) | 51 | 229 | | ~605 | 247 | | 64 | 51 | | | ~359 | |
| Queue Length 95th (ft) | 102 | 330 | | #816 | 352 | | #567 | #88 | | | #550 | |
| Internal Link Dist (ft) | | 226 | | | 350 | | | 57 | | | 627 | |
| Turn Bay Length (ft) | | | | | | | | | | | | |
| Base Capacity (vph) | 236 | 691 | | 249 | 702 | | 623 | 621 | | | 219 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 2 | 4 | | | 0 | |

| Lane Group | Ø8 |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | |
| Future Volume (vph) | |
| Ideal Flow (vphpl) | |
| Lane Width (ft) | |
| Grade (%) | |
| Storage Length (ft) | |
| Storage Lanes | |
| Taper Length (ft) | |
| Right Turn on Red | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Confl. Peds. (#/hr) | |
| Confl. Bikes (#/hr) | |
| Peak Hour Factor | |
| Growth Factor | |
| Heavy Vehicles (%) | |
| Bus Blockages (#/hr) | |
| Parking (#/hr) | |
| Mid-Block Traffic (%) | |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | |
| Turn Type | |
| Protected Phases | 8 |
| Permitted Phases | |
| Detector Phase | |
| Switch Phase | |
| Minimum Initial (s) | 5.0 |
| Minimum Split (s) | 23.5 |
| Total Split (s) | 69.0 |
| Total Split (%) | 58% |
| Yellow Time (s) | 3.5 |
| All-Red Time (s) | 2.0 |
| Lost Time Adjust (s) | |
| Total Lost Time (s) | |
| Lead/Lag | |
| Lead-Lag Optimize? | |
| Recall Mode | None |
| v/c Ratio | |
| Control Delay | |
| Queue Delay | |
| Total Delay | |
| Queue Length 50th (ft) | |
| Queue Length 95th (ft) | |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | |
| Starvation Cap Reductn | |

| Lane Group | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | 627 | | 228 | 0 | | 0 | 0 | | | 123 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | | 0 | |
| Reduced v/c Ratio | 0.39 | 6.11 | | 23.81 | 0.58 | | 0.83 | 0.81 | | | 3.56 | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 120 | |
| Actuated Cycle Length: 120 | |
| Natural Cycle: 120 | |
| Control Type: Actuated-Uncoordinated | |
| ~ Volume exceeds capacity, queue is theoretically infinite. | |
| Queue shown is maximum after two cycles. | |
| # 95th percentile volume exceeds capacity, queue may be longer. | |
| Queue shown is maximum after two cycles. | |

Splits and Phases: 137: Main St Connector/Tupper Rd & Route 6A



| Lane Group | Ø8 |
|---|---|
| Spillback Cap Reductn | |
| Storage Cap Reductn | |
| Reduced v/c Ratio | |

| Intersection Summary |
|---|

| Lane Group | SEL | SET | NWL | NWT | NEL | NET | SWT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 92 | 391 | 500 | 408 | 513 | 498 | 342 |
| v/c Ratio | 0.39 | 0.57 | 2.01 | 0.58 | 0.82 | 0.80 | 1.56 |
| Control Delay | 33.3 | 32.2 | 491.8 | 33.5 | 20.2 | 17.2 | 307.0 |
| Queue Delay | 0.0 | 89.9 | 75.3 | 0.0 | 0.1 | 0.1 | 15.8 |
| Total Delay | 33.3 | 122.1 | 567.1 | 33.5 | 20.2 | 17.4 | 322.8 |
| Queue Length 50th (ft) | 51 | 229 | ~605 | 247 | 64 | 51 | ~359 |
| Queue Length 95th (ft) | 102 | 330 | #816 | 352 | #567 | #88 | #550 |
| Internal Link Dist (ft) | | 226 | | 350 | | 57 | 627 |
| Turn Bay Length (ft) | | | | | | | |
| Base Capacity (vph) | 236 | 691 | 249 | 702 | 623 | 621 | 219 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 2 | 4 | 0 |
| Spillback Cap Reductn | 0 | 627 | 228 | 0 | 0 | 0 | 123 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.39 | 6.11 | 23.81 | 0.58 | 0.83 | 0.81 | 3.56 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
137: Main St Connector/Tupper Rd & Route 6A 01/11/2017

| Movement | SEL | SET | SER | NWL | NWT | NWR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 85 | 280 | 80 | 460 | 355 | 20 | 750 | 45 | 135 | 5 | 175 | 135 |
| Future Volume (vph) | 85 | 280 | 80 | 460 | 355 | 20 | 750 | 45 | 135 | 5 | 175 | 135 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 0.97 | | 1.00 | 0.99 | | 1.00 | 0.96 | | | 0.94 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 0.97 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 1801 | | 1770 | 1848 | | 1681 | 1641 | | | 1753 | |
| Flt Permitted | 0.33 | 1.00 | | 0.35 | 1.00 | | 0.95 | 0.97 | | | 1.00 | |
| Satd. Flow (perm) | 624 | 1801 | | 659 | 1848 | | 1681 | 1641 | | | 1753 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 304 | 87 | 500 | 386 | 22 | 815 | 49 | 147 | 5 | 190 | 147 |
| RTOR Reduction (vph) | 0 | 9 | 0 | 0 | 2 | 0 | 0 | 13 | 0 | 0 | 22 | 0 |
| Lane Group Flow (vph) | 92 | 382 | 0 | 500 | 406 | 0 | 513 | 485 | 0 | 0 | 320 | 0 |
| Turn Type | Perm | NA | | Perm | NA | | Split | NA | | custom | NA | |
| Protected Phases | | 6 | | | 2 | | 4 | 4 | | 3 | 3 | |
| Permitted Phases | 6 | | | 2 | | | | | | 8 | | |
| Actuated Green, G (s) | 45.5 | 45.5 | | 45.5 | 45.5 | | 44.5 | 44.5 | | | 13.5 | |
| Effective Green, g (s) | 45.5 | 45.5 | | 45.5 | 45.5 | | 44.5 | 44.5 | | | 13.5 | |
| Actuated g/C Ratio | 0.38 | 0.38 | | 0.38 | 0.38 | | 0.37 | 0.37 | | | 0.11 | |
| Clearance Time (s) | 5.5 | 5.5 | | 5.5 | 5.5 | | 5.5 | 5.5 | | | 5.5 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 236 | 682 | | 249 | 700 | | 623 | 608 | | | 197 | |
| v/s Ratio Prot | | 0.21 | | | 0.22 | | c0.31 | 0.30 | | | c0.18 | |
| v/s Ratio Perm | 0.15 | | | c0.76 | | | | | | | | |
| v/c Ratio | 0.39 | 0.56 | | 2.01 | 0.58 | | 0.82 | 0.80 | | | 1.62 | |
| Uniform Delay, d1 | 27.1 | 29.4 | | 37.2 | 29.6 | | 34.2 | 33.7 | | | 53.2 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 0.28 | 0.24 | | | 1.00 | |
| Incremental Delay, d2 | 1.1 | 1.1 | | 467.6 | 1.2 | | 7.0 | 5.8 | | | 302.6 | |
| Delay (s) | 28.2 | 30.4 | | 504.8 | 30.9 | | 16.5 | 14.1 | | | 355.8 | |
| Level of Service | C | C | | F | C | | B | B | | | F | |
| Approach Delay (s) | | 30.0 | | | 291.9 | | | 15.3 | | | 355.8 | |
| Approach LOS | | C | | | F | | | B | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 151.9 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.45 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 16.5 |
| Intersection Capacity Utilization | 107.2% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

| Lane Group | NBL | NBR | SET | SER | NWL | NWT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 0 | 445 | 400 | 0 | 1240 |
| Future Volume (vph) | 0 | 0 | 445 | 400 | 0 | 1240 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | 0% | | 0% | | | 0% |
| Storage Length (ft) | 0 | 0 | | 0 | 0 | |
| Storage Lanes | 0 | 0 | | 0 | 0 | |
| Taper Length (ft) | 25 | | | | 25 | |
| Link Speed (mph) | 30 | | 30 | | | 30 |
| Link Distance (ft) | 301 | | 380 | | | 306 |
| Travel Time (s) | 6.8 | | 8.6 | | | 7.0 |
| Confl. Peds. (#/hr) | | | | | | |
| Confl. Bikes (#/hr) | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | |
| Mid-Block Traffic (%) | 0% | | 0% | | | 0% |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 0 | 919 | 0 | 0 | 1348 |
| Sign Control | Stop | | Free | | | Free |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Control Type: Unsignalized | |

Lanes, Volumes, Timings
140: Exit 1C NB Ramp/Main St Connector & Route 130/Main St 01/11/2017

| Lane Group | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 220 | 0 | 175 | 0 | 120 | 280 | 0 | 755 | 70 | 90 | 625 | 0 |
| Future Volume (vph) | 220 | 0 | 175 | 0 | 120 | 280 | 0 | 755 | 70 | 90 | 625 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Grade (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Storage Length (ft) | 0 | | 0 | 0 | | 150 | 0 | | 0 | 0 | | 0 |
| Storage Lanes | 1 | | 1 | 0 | | 1 | 0 | | 0 | 0 | | 0 |
| Taper Length (ft) | 25 | | | 25 | | | 25 | | | 25 | | |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Link Speed (mph) | | 30 | | | 30 | | | 30 | | | 30 | |
| Link Distance (ft) | | 388 | | | 301 | | | 786 | | | 137 | |
| Travel Time (s) | | 8.8 | | | 6.8 | | | 17.9 | | | 3.1 | |
| Confl. Peds. (#/hr) | | | | | | | | | | | | |
| Confl. Bikes (#/hr) | | | | | | | | | | | | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Heavy Vehicles (%) | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% | 2% |
| Bus Blockages (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parking (#/hr) | | | | | | | | | | | | |
| Mid-Block Traffic (%) | | 0% | | | 0% | | | 0% | | | 0% | |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 239 | 0 | 190 | 0 | 130 | 304 | 0 | 897 | 0 | 0 | 777 | 0 |
| Turn Type | Perm | | Perm | | NA | Perm | | NA | | Perm | NA | |
| Protected Phases | | | | | 6 | | | 4 | | | 8 | |
| Permitted Phases | 2 | | 2 | | | 6 | | | | 8 | | |
| Detector Phase | 2 | | 2 | | 6 | 6 | | 4 | | 8 | 8 | |
| Switch Phase | | | | | | | | | | | | |
| Minimum Initial (s) | 5.0 | | 5.0 | | 5.0 | 5.0 | | 5.0 | | 5.0 | 5.0 | |
| Minimum Split (s) | 23.5 | | 23.5 | | 23.5 | 23.5 | | 23.5 | | 23.5 | 23.5 | |
| Total Split (s) | 51.0 | | 51.0 | | 51.0 | 51.0 | | 50.0 | | 69.0 | 69.0 | |
| Total Split (%) | 42.5% | | 42.5% | | 42.5% | 42.5% | | 41.7% | | 57.5% | 57.5% | |
| Yellow Time (s) | 3.5 | | 3.5 | | 3.5 | 3.5 | | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 2.0 | | 2.0 | | 2.0 | 2.0 | | 2.0 | | 2.0 | 2.0 | |
| Lost Time Adjust (s) | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | | | 0.0 | |
| Total Lost Time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Lead/Lag | | | | | | | | Lag | | | | |
| Lead-Lag Optimize? | | | | | | | | Yes | | | | |
| Recall Mode | None | | None | | Min | Min | | Min | | None | None | |
| v/c Ratio | 0.51 | | 0.26 | | 0.18 | 0.42 | | 0.69 | | | 2.23 | |
| Control Delay | 33.3 | | 4.4 | | 25.8 | 10.9 | | 34.9 | | | 580.3 | |
| Queue Delay | 0.0 | | 0.1 | | 0.0 | 0.0 | | 0.1 | | | 21.4 | |
| Total Delay | 33.3 | | 4.5 | | 25.8 | 10.9 | | 35.0 | | | 601.7 | |
| Queue Length 50th (ft) | 141 | | 0 | | 67 | 51 | | 303 | | | ~1008 | |
| Queue Length 95th (ft) | 223 | | 47 | | 113 | 125 | | 377 | | | m#504 | |
| Internal Link Dist (ft) | | 308 | | | 221 | | | 706 | | | 57 | |
| Turn Bay Length (ft) | | | | | | 150 | | | | | | |
| Base Capacity (vph) | 472 | | 718 | | 706 | 726 | | 1300 | | | 348 | |
| Starvation Cap Reductn | 0 | | 0 | | 0 | 0 | | 0 | | | 251 | |

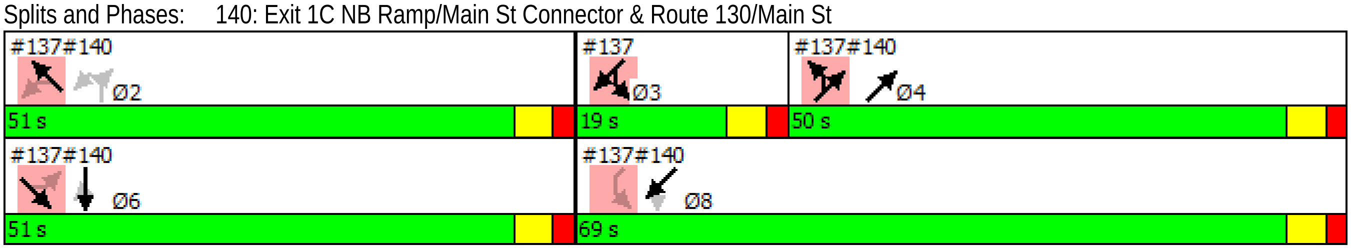
| Lane Group | Ø3 |
|---|---|
| Lane Configurations | |
| Traffic Volume (vph) | |
| Future Volume (vph) | |
| Ideal Flow (vphpl) | |
| Lane Width (ft) | |
| Grade (%) | |
| Storage Length (ft) | |
| Storage Lanes | |
| Taper Length (ft) | |
| Right Turn on Red | |
| Link Speed (mph) | |
| Link Distance (ft) | |
| Travel Time (s) | |
| Confl. Peds. (#/hr) | |
| Confl. Bikes (#/hr) | |
| Peak Hour Factor | |
| Growth Factor | |
| Heavy Vehicles (%) | |
| Bus Blockages (#/hr) | |
| Parking (#/hr) | |
| Mid-Block Traffic (%) | |
| Shared Lane Traffic (%) | |
| Lane Group Flow (vph) | |
| Turn Type | |
| Protected Phases | 3 |
| Permitted Phases | |
| Detector Phase | |
| Switch Phase | |
| Minimum Initial (s) | 5.0 |
| Minimum Split (s) | 10.5 |
| Total Split (s) | 19.0 |
| Total Split (%) | 16% |
| Yellow Time (s) | 3.5 |
| All-Red Time (s) | 2.0 |
| Lost Time Adjust (s) | |
| Total Lost Time (s) | |
| Lead/Lag | Lead |
| Lead-Lag Optimize? | Yes |
| Recall Mode | None |
| v/c Ratio | |
| Control Delay | |
| Queue Delay | |
| Total Delay | |
| Queue Length 50th (ft) | |
| Queue Length 95th (ft) | |
| Internal Link Dist (ft) | |
| Turn Bay Length (ft) | |
| Base Capacity (vph) | |
| Starvation Cap Reductn | |

| Lane Group | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spillback Cap Reductn | 0 | | 90 | | 0 | 0 | | 18 | | | 0 | |
| Storage Cap Reductn | 0 | | 0 | | 0 | 0 | | 0 | | | 0 | |
| Reduced v/c Ratio | 0.51 | | 0.30 | | 0.18 | 0.42 | | 0.70 | | | 8.01 | |

| Intersection Summary | |
|---|---|
| Area Type: | Other |
| Cycle Length: 120 | |
| Actuated Cycle Length: 120 | |
| Natural Cycle: 120 | |
| Control Type: Actuated-Uncoordinated | |

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 140: Exit 1C NB Ramp/Main St Connector & Route 130/Main St



| Lane Group | Ø3 |
|---|---|
| Spillback Cap Reductn | |
| Storage Cap Reductn | |
| Reduced v/c Ratio | |
| Intersection Summary | |

| Lane Group | NBL | NBR | SBT | SBR | NET | SWT |
|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 239 | 190 | 130 | 304 | 897 | 777 |
| v/c Ratio | 0.51 | 0.26 | 0.18 | 0.42 | 0.69 | 2.23 |
| Control Delay | 33.3 | 4.4 | 25.8 | 10.9 | 34.9 | 580.3 |
| Queue Delay | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 21.4 |
| Total Delay | 33.3 | 4.5 | 25.8 | 10.9 | 35.0 | 601.7 |
| Queue Length 50th (ft) | 141 | 0 | 67 | 51 | 303 | ~1008 |
| Queue Length 95th (ft) | 223 | 47 | 113 | 125 | 377 | m#504 |
| Internal Link Dist (ft) | | | 221 | | 706 | 57 |
| Turn Bay Length (ft) | | | | 150 | | |
| Base Capacity (vph) | 472 | 718 | 706 | 726 | 1300 | 348 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 251 |
| Spillback Cap Reductn | 0 | 90 | 0 | 0 | 18 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.51 | 0.30 | 0.18 | 0.42 | 0.70 | 8.01 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

| Movement | NBL | NBT | NBR | SBL | SBT | SBR | NEL | NET | NER | SWL | SWT | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 220 | 0 | 175 | 0 | 120 | 280 | 0 | 755 | 70 | 90 | 625 | 0 |
| Future Volume (vph) | 220 | 0 | 175 | 0 | 120 | 280 | 0 | 755 | 70 | 90 | 625 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Lane Util. Factor | 1.00 | | 1.00 | | 1.00 | 1.00 | | 0.95 | | | 1.00 | |
| Frt | 1.00 | | 0.85 | | 1.00 | 0.85 | | 0.99 | | | 1.00 | |
| Flt Protected | 0.95 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 0.99 | |
| Satd. Flow (prot) | 1770 | | 1583 | | 1863 | 1583 | | 3494 | | | 1851 | |
| Flt Permitted | 0.67 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 0.35 | |
| Satd. Flow (perm) | 1247 | | 1583 | | 1863 | 1583 | | 3494 | | | 658 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 239 | 0 | 190 | 0 | 130 | 304 | 0 | 821 | 76 | 98 | 679 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 118 | 0 | 0 | 126 | 0 | 6 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 239 | 0 | 72 | 0 | 130 | 178 | 0 | 891 | 0 | 0 | 777 | 0 |
| Turn Type | Perm | | Perm | | NA | Perm | | NA | | Perm | NA | |
| Protected Phases | | | | | 6 | | | 4 | | | 8 | |
| Permitted Phases | 2 | | 2 | | | 6 | | | | 8 | | |
| Actuated Green, G (s) | 45.5 | | 45.5 | | 45.5 | 45.5 | | 44.5 | | | 63.5 | |
| Effective Green, g (s) | 45.5 | | 45.5 | | 45.5 | 45.5 | | 44.5 | | | 63.5 | |
| Actuated g/C Ratio | 0.38 | | 0.38 | | 0.38 | 0.38 | | 0.37 | | | 0.53 | |
| Clearance Time (s) | 5.5 | | 5.5 | | 5.5 | 5.5 | | 5.5 | | | 5.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | | 3.0 | 3.0 | | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 472 | | 600 | | 706 | 600 | | 1295 | | | 348 | |
| v/s Ratio Prot | | | | | 0.07 | | | 0.26 | | | | |
| v/s Ratio Perm | c0.19 | | 0.05 | | | 0.11 | | | | | c1.18 | |
| v/c Ratio | 0.51 | | 0.12 | | 0.18 | 0.30 | | 0.69 | | | 2.23 | |
| Uniform Delay, d1 | 28.6 | | 24.2 | | 24.9 | 26.1 | | 31.9 | | | 28.2 | |
| Progression Factor | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | | | 1.75 | |
| Incremental Delay, d2 | 0.9 | | 0.1 | | 0.1 | 0.3 | | 1.5 | | | 555.6 | |
| Delay (s) | 29.5 | | 24.3 | | 25.0 | 26.3 | | 33.4 | | | 604.9 | |
| Level of Service | C | | C | | C | C | | C | | | F | |
| Approach Delay (s) | | 27.2 | | | 25.9 | | | 33.4 | | | 604.9 | |
| Approach LOS | | C | | | C | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 206.1 | HCM 2000 Level of Service | F |
| HCM 2000 Volume to Capacity ratio | 1.59 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 16.5 |
| Intersection Capacity Utilization | 92.3% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

HCM 2010 methodology does not support clustered intersections.

| Date | Name: (First) | Name: (Last) | City or Town: | Comment: | MassDOT Response |
|---|---|---|---|---|---|
| 5/22/2019 | Marie | Oliva | Buzzards Bay | The Cape Cod Canal Region Chamber supports MassDOT's recommendation to replace both bridges along with transportation improvements at both rotaries. | Thank you for your support. |
| 5/22/2019 | Mike | Nogrady | Newton Highlands | The focus area purposely excludes the rail bridge. Why doesn't "multi-modal" include rail? Why doesn't the report forcefully encourage more rail service to reduce traffic? This is an auto-centric report which hardly mentions rail options which have comparatively low environmental impacts. | Thank you for your feedback. The Cape Cod Canal Study did not include an examination of rail service to avoid a duplication of efforts given there was a parallel study of extending commuter rail service to Buzzards Bay. |
| 5/22/2019 | Chop | Hardenbergh | Freeport, Maine | The study lacks a focus on rail. The initial map of the study area does not even show the rail bridge or the rail lines. | Thank you for your feedback. The Cape Cod Canal Study did not include an examination of rail service to avoid a duplication of efforts given there was a parallel study of extending commuter rail service to Buzzards Bay being conducted by the Central Transportation Planning Staff of the Boston Metropolitan Planning Organization. |
| 5/23/2019 | Edward | Ganshirt | Lexington | Why do we still need this obsolete piece of infrastructure? Just fill it in and return the environment to before it's digging. We have GPS these days so it is simple for ships to go around Provincetown. | Thank you for your comments. The Cape Cod Canal is under the jurisdiction of the U.S. Army Corps of Engineers (USACE). We will forward your comments to the USACE. |
| 5/24/2019 | Michael | Gorenstein, P.E. | West Yarmouth | I would like to bring to your attention, that while improvements recommended in the Study might rectify a lot of problems in the area adjacent to the Cape Cod Canal, the main issue remains unsolved. The main problem of the existing road layout is the junction of Route 6 and Route 6A westbound in-front of the Sagamore Bridge. | Thank you for your feedback. |
| | | | | The connection might be made via a tunnel, which would be easier, environmentally friendlier and more cost effective solution, learning from the BigDig experience. The location of the tunnel would need to be selected with appropriate study, but it appears that the old road in the alignment of Old Plymouth Road on the north side and Pleasant Street on the south side of the canal would be a good point to begin. With a direct connection to Route 3A travelers from Cape will have a choice to return to Route 3 north on several interchanges or follow Route 6 west without jamming entrances to the Sagamore Bridge. It would be even more important if evacuation of the Cape Cod population is ordered in case of hurricanes or other catastrophic events, providing redundancy to the existing bridges. | The Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to replace its bridges or undertake major rehabilitation instead. Moreover, as MassDOT's study progressed, it focused on improving existing infrastructure rather than creating new infrastructure. MassDOT will continue to work closely and collaboratively with its federal partners to ensure that both the bridges and adjacent infrastructure provide safe, efficient and multimodal mobility for the long-term, while also minimizing impacts to private right-of-way, environmental, cultural, and social resources. |
| | | | | The Cape Cod side entrance to Sagamore bridge is congested regularly during high season, mostly because of traffic merging from Route 6A. Moving the junction a mile or 2 east would only move traffic jam east. This problem was recommended over and over again to be solved by adding a lane on the Sagamore Bridge, which is not really feasible, or building a parallel bridge, which is not cost effective. | As you note, congestion near the Sagamore Bridge can be attributed to the location of the merge point of the existing on and off-ramp for Exit 1C on the westbound side of Route 6. These ramps are also substandard in length, exacerbating the delays and congestion on Route 6 westbound. Relocated on and off-ramp would be designed and constructed to current engineering standards, with the effect of relieving congestion rather than moving the issue 'downstream'. |
| | | | | Meanwhile the solution might be found in the history of the Cape Cod roads. Before the canal has been built the main road connecting Cape Cod peninsula to Boston was what we now call Route 3A and Route 6A. Connecting these 2 roads directly across the canal would solve of the problems associated with Sagamore Bridge traffic jams westbound and eastbound. It will also allow traffic to by-pass the againg bridge during maintenance, repairs or replacement. | As stated previously, as MassDOT's study progressed, it focused on improving existing infrastructure rather than creating new infrastructure. |
| 5/25/2019 | NA | NA | Buzzards Bay | I think a third bridge should be built connecting route 3A to route 6A. | Thank you for your feedback. As the study progressed, MassDOT focused on improving existing infrastructure. |
| | | | | And improve existing bridges. | The Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to replace its bridges or undertake major rehabilitation instead. If the USACE proceeds with a replacement recommendation, it would be designed to current engineering standards. |
| | | | | And create more lanes on route 6, 6A, and route 28. | The study focused on improving existing infrastructure, while minimizing significant capacity increases that are not in line with the character of Cape Cod. |
| | | | | And have a toll for non residents only. | The study did not include an examination of tolling scenarios. |
| 5/27/2019 | jeffrey | kaufman | longmeadow | this is a totally thoughtful approach. the times/queue length estimates for peak delays are low. I wonder whether these have been validated against current experience. only today, 5/27/19, the delay from exit 5 on rt 6 to the sagamore bridge north end was over 45 min. an alternative measure might be to look at number days with more than 1 hr of such a delay that time to get off the cape would be more than 1/2 hr, which is truly a "bad day" scenario. those peak periods of misery seem to be increasing every year. | Thank you for your comments. The existing conditions analysis did include a validation process to compare the traffic modeling software to current travel conditions. |
| | | | | all the proposals make sense. I have been driving these roads for 30 years, so I can appreciate all the options. the subtlety of some of the benefits is key, and I hope that people understand what is being proposed. for example, the benefit of preventing full circular flow at the Bourne rotary is clear, less crossing of traffic and less hindrance for flow into the circle. the benefit of moving the 1C entrance/exit for rt 6 at the sagamore base likewise is clear. that flow onto rt 6 always causes major disruptions, especially if the vehicles merging are long (bus, truck, any towed trailer/boat). I hope we can make this plan happen. especially new bridges! | Thank you for your feedback and support. |

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| 5/27/2019 | Don | Hayward | Monument Beach | No study will be complete without an economic evaluation of the Cape Cod Canal itself and it's value "today" as a shipping alternative waterway. In my view, both bridges should be replaced with raised causeways with large sluiceways for tidal flow power generation.<br>The usefulness of building 125 foot high bridges over an obsolete canal is as silly as it gets.<br>This canal would not be built today and as such is functionally obsolete | Thank you for your feedback. The Cape Cod Canal is under the jurisdiction of the U.S. Army Corps of Engineers (USACE). We will forward your comments to the USACE. |
| 5/28/2019 | Joanne | Foley | West Falmouth | I have a suggestion, which I believe will markedly reduce the traffic congestion leaving the Cape via the Bourne Bridge. This idea could be implemented within a reasonable amount of time and would be reasonably inexpensive. It is a short-term partial alleviation until you determine the long-term course of action.<br>For cars planning to use Sandwich Road, the first exit off the Bourne Rotary, adding an exit lane approximately one quarter a mile (or even better one half mile before the rotary) for those vehicles only would facilitate the flow of traffic going over the bridge. The current breakdown lane could be used for this purpose.<br>There is a small plot of land to the right of the entrance to the rotary, which could be reconfigured to provide an entrance "ramp" to Sandwich Road. Thus, these vehicles would avoid entering the rotary circle altogether. Of course, the land is privately owned, and eminent doamin might be required to obtain a parcel of it. But that expense and the cost of the minimal road construction with the appropriate signage would be the majority of the expenditure.<br>I believe that this investment is well worth the return for the eased flow of traffic traveling over the Bourne Bridge to the mainland. | Thank you for your feedback and suggestions. A dedicated Route 28 northbound ramp to Sandwich Road was included in the study's alternatives development and analysis. However, the recommended Case 3A does not include this element and instead includes reconstructing Bourne Rotary as a modern interchange. As any recommendations move forward into project development, there will be additional public involvement opportunities to consider refinement of the alternatives. We look forward to working with our local and regional partners on these very important recommendations. |
| 5/29/2019 | Jeffrey | Smith | Everett | During bridge construction, Mass DOT, MBTA & the Cape Cod RTA should run the Cape Flyer. This will help alleviate the traffic during the construction. | Thank you for your feedback. The Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to replace its bridges or undertake major rehabilitation instead. MassDOT will continue to coordinate with the USACE and regional partners to ensure mitigation of impacts during any future construction, which could include operating additional Cape Flyer service. |
| 6/7/2019 | Paul | Tilton, P.E. | Sandwich | On behalf of the Town of Sandwich, thank you for the opportunity to participate in the Cape Cod Canal Transportation Study. The Canal Area transportation system plays a vital role in Sandwich's quality of life and function as a prospering town. Traffic congestion in this area greatly affects tourism, the economy, emergency response and the overall well-being of the residents of Sandwich throughout the year.<br>The town is grateful for the opportunity to host past meetings, participate on the working group, and to provide comments on this very important study. The MassDOT draft final report is very comprehensive and provides many valuable options to improve traffic throughout the Upper Cape region, including Sandwich. Reviewing the report in its entirety provides the town a good perspective of the system-wide transportation recommendations and its impact on Sandwich.<br>While the town reviewed all transportation recommendations in the MassDOT report's study/focus area, we are focusing our comments on those directly affecting Sandwich. The town is supportive of the objectives listed in the MassDOT report and our comments reflect these same goals for the region. Below are comments on specific MassDOT recommendations in the report. | Thank you for your feedback, comments, and support. |
| | | | | Route 130 at Cotuit Road: While improvements made by MassDOT back in 2001 at this location enhanced traffic conditions, the town recognizes the need to further address traffic related issues, as noted in the MassDOT Report. The town supports the MassDOT recommendation of a traffic signal that improves safety and operations, being mindful of maintaining the flow of traffic on Route 130. A signal will alleviate difficult left-turning movements from Cotuit Road, which some motorists avoid by cutting through a commercial development. The town requests that the signal design include an emergency pre-emption system and also be coordinated with the Route 130/Jan Sebastian Drive signal, if appropriate. The town supports the recommendation of providing ADA compliant sidewalks along Route 130 at this location. To further enhance pedestrian safety, the town requests that the sidewalk be continued beyond Tradewinds Plaza to Heritage Park, which is a high activity commercial area frequented by many children walking/biking to the movie theater. | As any recommendations move forward into project development, design elements you have requested or suggested would be taken into account as part of the project's scoping process. |

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| 6/7/2019 | Paul | Tilton, P.E. | Sandwich | Route 6 Exit 1C Relocation (including Route 6A at Route 130/Tupper Road intersection): The town supports any traffic recommendation that reduces Route 6 backups as this negatively affects the interchanges and, in turn, the surrounding local roadway system in Sandwich. The town concurs that the substandard Exit 1C contributes to the traffic problems and bottleneck starting at the Sagamore Bridge. The town also supports improvements at the Route 130/Route 6A/Tupper Road intersection due to the high crash rate (0.59) and poor future level of service (LOS F). In order for the town to support this option, we would like the oppurtunity to review further information related to traffic operations. For example, we request the following information be provided related to the Exit 1C relocation option:<br>1) The current access road (Cranberry Highway) to Exit 1C is a four-lane road that appears to be designed to handle the capacity of exiting and entering highway traffic. Is Exit 1C the primary bottleneck or is a substandard bridge the bottleneck? Can a new bridge, with standard design and more capacity, better accommodate existing Exit 1C traffic?<br>2) What is the capacity (e.g., 2 lanes, 4 lanes) of the proposed Exit 1C ramp?<br>3) Will the adjacent roadway system (Route 6A, Route 130, Tupper Road, and adjacent cut through local roads) be able to handle this large volume of traffic to/from Route 6?<br>4) The town requests review of a queue length modeling analysis of the before-and-after Exit 1C. Road maps showing queues would be helpful in this regard. | 1) The on and off-ramps at Exit 1C are substandard in length which contributes to the congestion and delays on Route 6 westbound. Additionally, the bridges have substandard design elements including a steep grade that also exacerbates the congestion associated with the length of the Exit 1C on and off-ramps. Ultimately, if the USACE's decision is to replace the Sagamore Bridge, a new bridge would be designed with lower grades which would bypass the current Exit 1C.<br>2) The proposed on and off-ramps for a relocated Exit 1C on Route 6 westbound would be one lane, and the connector road would be one-lane in each direction for most of its length, and widen to two lanes at the entrance to the proposed roundabout at the eastern end.<br>3) While it is assumed that trip patterns may shift to a relocated Exit 1C, the distance from the existing interchange is not considered enough to change local volumes significantly. Moreover, by providing access to Route 6 further east on Route 6A, the relocation may potentially reduce volumes on certain facilities to the west of new on and off-ramps.<br>4) We will provide the Town with additional analysis data from the study.<br><br>As any recommendations move forward into project development, these type of issues would be examined in more detail as part of the project development process and environmental permitting analysis; There will be additional public involvement opportunities to consider refinement of the alternatives. We look forward to working with our local and regional partners on these very important recommendations. |
| | | | | Route 6 Additional Eastbound Travel Lane: The proposed additional eastbound travel lane on Route 6 from the Mid-Cape Connector to Exit 2 appears to have merit to accommodate merges, diverges and weaves along this critical section of Route 6. However, the the town has concerns related to the increased capacity (and volume) added to Route 6 as motorist approach Exit 2. While the existing 2 lanes on Route 6 may not be ideal at this location, it has the effect of metering traffic as it enters the Exit 2 ramps. What impact will this increased volume have on immediate local roads (e.g., Route 130) and Sandwich Village? Will local road upgrades be needed to accommodate increased traffic volume? | As any recommendations move forward into project development, these types of issues would be examined in more detail as part of the project development process and environmental permitting analysis; There will be additional public involvement opportunities to consider refinement of the alternatives. We look forward to working with our local and regional partners on these very important recommendations. |
| | | | | Multi-modal Transportation - Exit 2 Park and Ride Lot: The town supports multi-modal transportation and proving alternatives to reduce single occupant vehicles. The proposed Exit 2 park and ride provides easy access to Route 6, a closer alternative for local carpoolers, and a potential parking lot for the future state-funded Service Road shared-use-path. However, the town has the following comments/concerns related to the proposed location:<br>1) In 2013, MassDOT added a separate southbound left turn lane on Route 130 at Service Road as part of the "Phase 1" Exit 2 Interchange project. However, the intersection still presents safety issuesfor motorist turning from Service Road. Future "Phase 2" plans at this interchange included studying further improvements at the Service Road intersection as well as a Route 6 westbound slip ramp on the northwest quadrant of the interchange connecting Route 6 westbound to Route 130 northbound. As part of the park and ride proposal, the town requests that "Phase 2" options be considered.<br>2) The Town of Sandwich's Bicycle and Pedestrian Master Plan includes extending the future MassDOT-funded Service Road shared-use-path into Sandwich Village along Route 130. The park and ride plans at the Exit 2 location should consider accommodations for the extension of the shared-use-path near the interchange and along Route 130, particularly under the Route 6 overpass.<br>3) The topography is very challenging in this area. How much earthwork will be involved and how will the proposed lot affect aesthetics? Will the lot impact the proposed Service Road shared-use-path planned for 2022?<br>4) The town also requests information on security and safety at the Park and Ride site. Is the lot a daily car-sharing lot or will it allow overnight parking and bus transportation? If overnight parking is allow, will the lot be monitored for safety?<br>5) As an option to avoid the challenges of the proposed location, the town requests consideration of an alternative location, such as the area adjacent to the MassDOT Highway Maintenance facility on Route 130 (northwest quadrant of interchange). | 1 and 2) If a park and ride lot recommendation were to move forward into project development, your requests are a matter of public record and would be considered in the project scoping process.<br>3) The recommended park and ride lot alternative was developed with minimal changes to the existing topography on the site. However, any expansion beyond the recommended 100 spaces would need to consider impacts and changes to the topography.<br>4) It is assumed that the park and ride lot would serve daily and overnight parking, as well as connections to local and regional bus service. MassDOT does not typically actively monitor their park and ride lots.<br>5) If a park and ride lot recommendation were to move forward into project development, your requests are a matter of public record and would be considered in the project scoping process. |

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| 6/7/2019 | Paul | Tilton, P.E. | Sandwich | Other Comments/Concerns: The town requests consideration of improvements at two locations on Quaker Meetinghouse Road that experience safety and operational related issues. Quaker Meetinghouse Road is a major north-south collector that intersects State Highway Route 6 and Route 6A. While further away from the Canal Area, these locations are critical to the regional transportation system and will likely be impacted by the full buildout improvements recommended in the MassDOT report. It's important to note that Quaker Meetinghouse Road is part of a Cape Cod Regional Transit Authority bus route (The Sandwich Line) and also an important emergency evacuation route (with an emergency shelter at Sandwich High School). The 2 locations of concern are shown below:<br>Route 6 Exit 3 Interchange at Quaker Meetinghouse Road - Currently, the Exit 3 interchange experiences safety and operational related issues, particularly in the summer and during peak Sandwich High School morning arrival times. The MassDOT report (Table 3-3) indicates that the Exit 3 Interchange experiences delay (LOS E) under the 2040 No-Build condition at 3 out of 4 ramp locations. It's important to note that the town is currently funding design for a shared-use-path along the Service Road adjacent to Route 6, earmarked for MassDOT-funded construction in 2022. The design includes a HAWK signal system and ramp alterations at Exit 3. Due to the safety and operational concerns related to the this interchange, the town requests further review of this intersection related to long term improvements that addresses safety, capacity, and multi-modal use of this location.<br><br>State Route 6A at Quaker Meetinghouse Road/Springhill Road - The town frequently receives requests from the public to improve this location due to safety related issues. The intersection is listed on the Cape Cod Metropolitan Planning Organization's Top 50 Crash Rate Locations (rate of 1.3). The intersection is not a typical 4-way intersection as the two minor street approaches on Quaker Meetinghouse Road and Springhill Road are offset. This creates awkward and difficult movements for motorists and uncertainty about who has the right of way when entering the intersection. The town has sent previous requests to MassDOT to review this location for improvements. Though not analyzed as part of the MassDOT Report, the town requests that this location be included in the study area and considered for improvements. | Thank you for sharing your comments and concerns, which are being included in the study's formal response to comments, and would be considered as any recommendations move forward into project development. This would entail more detailed analysis and designed of the alternatives, as well as additional public involvement opportunities. |
| | | | | Clarification on Route 130 (Main Street) at Tupper Road Intersection - This intersection is listed under "signalized intersections" in Tables 2-19 and 3-3 of the MassDOT Report and shows improving levels of service from existing to 2040 No-Build (no improvement) conditions. The town is requesting clarification about the exact location and LOS operations at this intersection. | Thank you for your feedback, the Route 130 (Main Street) at Tupper Road intersection is currently unsignalized and the relevant tables will be updated in the final report. |
| | | | | Conclusion: The town is grateful for the efforts on behalf of MassDOT and United States Army Corps of Engineers (USACE) to address long-standing transportation issues in the canal area and entire Upper Cape region. Sandwich has long been impacted by traffic congestion along its main and local roads and welcomes this comprehensive review of the transportation system to develop both short and long term solutions. The Cape Cod Canal Transportation Study provides a positive look into the future to alleviate many of our concerns and ease Sandwich from the constrains of traffic congestion.<br>While supportive of the major concepts and receptive to alterations proposed in Sandwich, the town has provided these comments with the hope of advancing towards a final transportation plan that meets both the regional objectives of MassDOT and those of the Town of Sandwich. We look forward to continuing our good working relationship with MassDOT to further develop these plans.<br>Thank you again for the opportunity to participate with the study and please contact us if you wish to discuss this letter. | Thank you for your support, and we look forward to working with the Town of Sandwich on implementation. |
| 6/10/2019 | Mark | Wirtanen | West Barnstable | Having witnessed the vast improvement from the Sagamore rotary flyover I hope the Bourne rotary flyover happens as soon as possible. Also if it is not already in the plan a double barrelling of Sanwich Road on the south side of the canal is very much needed. | Thank your for your feedback. |
| 6/12/2019 | James | Edwards | South Yarmouth | I would like to see design changes on the Scenic highway (Rt. 6).<br>Currently, it has a traffic signal at the Edgehill Road intersection,<br>I would like to propose modernizing the Scenic highway (Rt 6) by adding a service road in both directions. The entrance ramp will start at the 1st parking lot and the exit ramp will end at the 2nd parking lot with addition of a median barrier and removal of the traffic signal.at that location.<br>This would facilitate traffic flow from one end at the Bourne bridge to traffic signal at base of the Sagamore bridge. | Thank you for your feedback. The study did not identify the Scenic Highway corridor between the Bourne and Sagamore Bridges as an issue as part of the assessment of Existing and Future No-Build Conditions. Further, the study focused on improving existing infrastructure, while minimizing significant capacity increases that are not in line with the character of Cape Cod. |
| | | | | Rather than a 6 lane bridge, I would like to see a 8 lane bridge (4 for each directions) at the Sagamore bridge to eliminate traffic congestion when the bridge undergoes maintenance as it currently does. | The Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to replace its bridges or undertake major rehabilitation instead. If the USACE proceeds with a replacement recommendation, the design would include lane shoulders that would serve to provide additional space for maintenance of the bridges. |
| | | | | The addition of the auxiliary lane starting at the exit 2 on Route 3 and ending at exit 2 on Route 6 is a good place to start. | Thank you for your suggestion. |
| | | | | The flyover at the Bourne bridge is a good place to start. I would like to suggest adding a service road along the Scenic road to facilitate traffic flow to the exit ramp on the Sagamore bridge. | Thank you for your suggestion. |

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| 6/12/2019 | Wesley | Ewell | Bourne | Your proposal for reconfiguring Belmont Circle would be unnecessarily expensive, environmentally damaging, and would choke off the downtown area that Bourne has been working so hard to revitalize.<br>Belmont Circle works well as it is except for one clearly obvious and patently stupid flaw: making down-Cape traffic go around the circle. Just run that traffic straight to a light at Scenic Highway/Maine Street and leave the rest alone. At the same time, widen the access to Route 25 to two lanes in each direction. | Thank you for your feedback. MassDOT's studies focus on minimizing impacts including environmentally sensitive areas. As you suggest, the conceptual design for Belmont Circle under Case 3A is intended to facilitate through traffic and those destined for Main Street in Bourne by separating regional and local movements. Additionally, the recommendation to construct a new on-ramp from Scenic Highway westbound to Route 25 is intended to remove regional movements from Belmont Circle. |
| 6/12/2019 | Wesley | Ewell | Bourne | You document that 59% of eastbound traffic crossing the Bourne Bridge on a summer Saturday goes three-quarters of the way around the rotary and then down two-lane Sandwich Road to the Mid-Cape Highway.<br>Why not consider a direct connection from Route 25 at the Plymouth town line, across a high-level bridge at Bournedale, to a slip-intersection with the Mid-Cape near the power lines. That would take half the traffic off the existing bridges and solve the rotary back-ups, while reducing travel distance by four miles. | Thank you for your feedback. As the study progressed, MassDOT focused on improving existing infrastructure rather than to create new infrastructure. Additionally, Chapter 4 of the study includes a high-level examination of concepts that connect Route 25 more directly to Route 6. These alternatives were removed from further detailed analysis due to the expected impacts, including those to environmental and cultural resources. |
| 6/15/2019 | Barb | Rakers | Marston Mills | Summer is coming, you need to fix the traffic jam in summer for locals (et al) by fixing:<br>1) Route 130 & Great Neck Road (I have suggestion)<br>2) Route 130 & Route 28 (Good luck with that one!)<br>State Hwy Planners: How to fix girdlock during summer at corner Route 130 and Great Neck Road. (Fairly heavy traffic feeds in from South Sandwich, coming from 28 toward Route 6 on 130 backs up past South Sandwich) You have lights for 2 lanes at that light but only room enough for 1 vehicle at stop line. People cut through Town Hall parking lot from Great Neck onto 130 heading toward 28. | Thank you for your feedback. The intersections of Route 130 and Great Neck Road, and Route 130 and Route 28 are outside of our study's Focus Area. We will forward your comments and suggestions to our District 5 office. |
| 6/18/2019 | Jeffrey | Miller | Sagamore | Dear Sir,<br><br>It has been brought to our attention that the Mass D.O.T is planning changes to both Bourne and Sagamore Bridge by our neighbor Mr. Jeffrey Bilezikian of the Christmas Tree Shop (Sagamore).<br><br>Upon reviewing this report we were dismayed, that as a business, so close to the Sagamore Bridge. That your plan will no doubt affect our business in a negative manner. We were never notified of the bridge changes. So, we hope our input will be taken into consideration.<br><br>Closing Exit 1C Cape Side of the Sagamore Bridge will be devastating to our business. We understand the bridges need to be replaced and the bottlenecks smoothed out, but there are viable businesses that will be greatly affected financially in the Sagamore area. It seems the plan set by you appears to help Pedestrians and bicyclists more than the people of Sagamore. Just another obstacle for the People of Sagamore.<br><br>We are members of the Cape Cod Chamber of Commerce since we were first opened in 1995. We have been serving the citizens of Bourne and The Tourists of Cape Cod since then and have created a solid business. Do to the fact that people could get off the bridge, stop in get what they need for fishing, then travel down 6A with ease. The bridges are tripling in width, but continue to come from a 2 lane highway. That will bottleneck into an other 2 lane highway that will just create more havoc.<br><br>Frankly we are very disappointed that no Town or State Official, Cape Cod Chamber of Commerce Member, nor any State Representative, gave us the time of day or even a small notification in the mail stating these Massive bridges changes. We heard about these Crippling Changes thru Mr. Bilezkian when he stopped by to tell us.<br><br>Consider our position to be Against these Bridge Plans. Feel free to contact us for our input and<br>our 20+ years of knowledge of the area.<br><br>Sheila, Bruce and Jeffrey Miller - Owners<br><br>Canal Bait and Tackle | Thank you for your feedback. As part of the Cape Cod Canal Transportation Study, there was general public outreach conducted, but there was no direct contact with adjacent property owners. Additionally, the U.S. Army Corps of Engineers (USACE) is currently conducting a study that will determine whether to conduct major rehabilitation or replace its bridges. If the USACE's decision is to replace the existing bridges, they will be designed to meet current design standards which may impact adjacent properties and require changes to the transportation network of roadways and on/off ramps in the area. As any recommendations move forward, these type of issues would be examined in more detail as part of the project development process and environmental permitting analysis, and we have added language to MassDOT's study recommendations that reflects your concerns. There will also be additional public involvement opportunities to consider refinement of the alternatives.<br><br>MassDOT understands your concerns and will work with you to minimize any impacts to properties and businesses in the Cape Cod Canal area. Please be assured that as any projects move forward, there will be additional public involvement and coordination with property owners, abutters, local and regional stakeholders that will serve to minimize all impacts and maximize potential benefits. |

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| 6/18/2019 | Thomas | Guerino | Bourne | On behalf of the Town of the Bourne, we want to thank you for your guidance and professionalism during the Cape Cod Canal Transportation Study process and the opportunity to contribute to the study. Unlike any other town on Cape Cod, the Cape Cod Canal area transportation system has a significant impact on the quality of life of residents and has a daily impact on the residents of Bourne. Traffic congestion around the Cape Cod Canal has a daily impact on the economy, emergency response and the overall well-being of the residents of Bourne throughout the year.<br>The Sagamore and Bourne Bridges are owned and operated by the U.S. Army Corps of Engineers. The Town of Bourne understands that the U.S. Army Corps of Engineers is currently preparing a "Major Rehabilitation Evaluation Report" that will determine whether the U.S. Army Corps of Engineers should continue to perform lon-term maintenance on the bridges or replace the exisiting Bourne and Sagamore Bridges. MassDOT controls the highways approaching the Bourne and Sagamore Bridges (Route 25, Route 3, Route 6, and Route 28) as well as the roadways between the Bourne and Sagamore Bridges (Scenic Highway and Sandwich Road). The MassDOT Cape Cod Canal Transportation Study offers recommendation for al these pieces of infrastructure. Below are comments on specific MassDOT recommendations in the Report. | Thank you for your support and feedback. |
| | | | | Replacing the Bourne and Sagamore Bridges and Bourne Rotary: The MassDOT Cape Cod Canal Transportation Study (Case 3A) recommends replacement of both the Bourne and Sagamore Bridges, and replacing the Bourne Rotary with a standard grade-separated highway interchange. The Town of Bourne supports replacing the Bourne and Sagamore Bridges and replacing the Bourne Rotary. In the event that the U.S. Army Corps of Engineers does not replace the Bourne and Sagamore Bridges, the Town of Bourne recommends replacing the Bourne Rotary with a new highway interchange. | Thank you for your support and feedback. |
| | | | | Belmont Circle: Belmont Circle is located at the entrance to downtown Bourne (Main Street). Main Street is currently experiencing a revitalization including a one-hundred room hotel and many restaurants. The Town of Bourne and the Commonwealth of Massachusetts have made significant investments into the infrastructure of Main Street including a $2.3 million park/playground, a new Police Station, and a new wastewater treatment plant to accommodate the recent development. As the entrance to Main Street, we are concerned with the look and feel of the front door of our downtown. | As any recommendations move forward into project development, there would be additional coordination with the Town of Bourne on project scoping and design elements. |
| | | | | New Highway Ramp from Scenic Highway to Route 25The Town of Bourne supports the installation of a new highway ramp continuing Scenic Highway to Route 25. This highway ramp would allow vehicles to get on Route 25 northbound without having to travel through Belmont Circle. | Thank you for your support. |
| | | | | Route 6 Westbound at Exit 1C: The Town of Bourne is not in support of replacing Exit 1C. Exit 1C supplies access to the Sagamore Neighborhood of Bourne, and is a critical connection for travelers between the Bourne and Sagamore Bridges. Relocating Exit 1C would add significant travel time for residents of Bourne and travelers across Cape Cod. | Thank you for your feedback. |
| | | | | Route 6A (Sandwich Road) at Cranberry Highway: Town staff supports reconstructing the Route 6A (Sandwich Road) at Cranberry Highway intersection. Town staff recommends that this improvement move forward immediately and that MassDOT not wait until the U.S. Army Corps of Engineers has made a decision about the Bourne and Sagamore Bridges. | Thank you for your feedback. |
| | | | | Multi-Modal Transportation: Town staff supports multi-modal transportation and providing alternatives to reducing driving. The Cape Cod Canal is a significant recreational facility in the Town of Bourne. The Town of Bourne is also joining other Cape townsin providing a shared-use parth from Woods Hole in Falmouth to the tip of Cape Cod in Provincetown. The Town of Bourne also wants to provide safe pedestrian and bicycle connections between the northern portions of Bourne with the southern portion of Bourne. Safe pedestrian and bicycle access can best be accomplished with the construction of new Bourne and Sagamore Bridges. The new Bourne and Sagamore Bridges would include safe pedestrian and bicycle accommodations. | As you note in your comment letter, the Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to whether to replace its bridges or undertake major rehabilitation instead. If the decision is to replace the bridges, they will be designed and constructed with bicycle and pedestrian facilities. |
| | | | | Conclusion: The Town of Bourne thanks MassDOT and United States Army Corps of Engineers for their efforts to address the transportation issues around the Cape Cod Canal. Bourne has long been impacted by traffic congestion associated with the Cape Cod Canal. The Cape Cod Canal Transportation Study provides an oppurtunity to eliminate the significant transportation bottlenecks associated with the Cape Cod Canal. We look forward to continuing working with MassDOT and assisting bringing these plans to implementation. | Thank you for your support, and we look forward to working with the Town of Bourne on implementation. |

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| 6/20/2019 | Robert | Dwyer | Pocasset | In general I think the recommendation for option 3A was well supported by this detailed study.<br><br>However I have comments specifically about the Bourne Rotary plans, which I believe are elements to be of option three and their impacts on the town of Bourne and the local citizens.<br><br>First, the plan needs to consider options for both the short term and the long term access to two parcels at the southeast and southwest corners around the rotary:<br>-the Stop & Shop property to the south east and<br>-the future Wawa gas station property to the south west.<br>The implementation of the elements B2 in the recommended plan is going to take many years, and in the meantime the development of both of those corners is going to be in limbo. The B2 reconstruction design of the Bourne Rotary needs to include detailed plans that will allow access to both of those properties once B2 designs are fully implemented, but are firm enough very soon, so that both properties can be developed in the short term and put back into productive use, (and on the tax rolls for the Town of Bourne). Both properties need to be accessible both for traffic passing through - going over the bridge and south along route 28 or MacArthur Boulevard, and also for local traffic around Trowbridge Rd., Sandwich Road etc.<br><br>Second, an extremely useful element that could be added with minimal additional disruption would be a slip road along the east side of MacArthur Boulevard between the new construction at the rotary and the Bourne ISWM and the adjacent Sportsmens club to the south. This would allow access to the B2 interchange by local ISWM/Club traffic that doesn't need to merge onto, cross, or exit from MacArthur Boulevard otherwise. Aat present traffic coming from the north over the bridge to the ISWM facility have to make a hazardous left turn across both lanes of northbound traffic at MacArthur Boulevard. Some of this traffic is heavy, slow tractor trailer rigs with trash from Off-Cape towns. Traffic accessing the ISWM facility from the south and later exiting the ISWM facility needs to make a complete circle around the existing Bourne rotary to head back south on MacArthur Boulevard, adding unnecessary vehicle load at the rotary. A separated slip road along the east side of MacArthur Boulevard could allow all of this traffic to completely bypass and not mix with the north-south through traffic headed over the bridge. Robert Dwyer, Pocasset Village Assn., 25 Kenwood Rd., Pocasset MA 02559, rdwyerphd@gmail.com | Thank you for your support and feedback. Your submitted comments and suggestions are being included in the study's formal response to comments, and would be considered as any recommendations move forward into project development. This would entail more detailed analysis and designed of the alternatives, as well as additional public involvement opportunities. |
| 6/20/2019 | Ellen | Carlson | Sandwich | Thank you for all the in depth work and consultation that went into this draft. I hope that you will consider holding a public meeting or two in Sandwich or at UCT during the next phases of planning. | Thank you for your support. As any recommendations move forward into project development, there will be additional public involvement opportunities. |
| | | | | I support the proposed improvements at Sandwich Road at the Bourne Rotary Connector. Signalization at that intersection is essential for UCT.I support the left turn lane and bike/ped improvements proposed for Route 6A ( Sandwich Road) @ Cranberry Highway. I support the signalization and bike/ped access improvements at Route 130 @ Cotuit Road | Thank you for your support. |
| | | | | Re: P3 Alternatives<br>Route 6 Exit 1C Relocation<br>This is an important gateway intersection entering the town of Sandwich as you travel eastbound on 6A. When you get to the intersection of 6A/Tupper/130 you see community welcome signs and it is the selected location of a major installation of the "giants" (Herald Angels) during the winter season. Great care must be taken in the design approach to this intersection to honor its role as a gateway to our community. Please consult with our town boards on its design.<br>I prefer the Alternative 2 -- 4 leg roundabout as I think it may present the best opportunity to design a positive, gateway experience for our town. | Thank you for your support. As any recommendations move forward into project development, there will be additional public involvement opportunities, including coordination and communication with the Towns of Bourne and Sandwich. |
| | | | | Re: Bourne Rotary<br>I support Alternative 1 -- signalized intersection at Sandwich Road is essential to support safe access to UCT, I prefer the scale of the road depicted in this Alternative. The roads in Alternative 2 appear over scale in our Cape Cod context. | Thank you for your support |
| | | | | Re: New park and ride lot on Route 130 Exit 2<br>Please consult with host town on this placement. This is already a pretty congested area and we only just recently got it under control.<br>Also, how would this lot be served? Would there be scheduled bus service? A lot of space could be freed up at the Sagamore lot if long-term parking were not tolerated. People park in prime spots for weeks at a time. | As any recommendations move forward into project development, there will be additional coordination with the Town of Sandwich. It is assumed that a new park and ride lot would be served by bus service, and additional coordination would be necessary with local and regional bus providers as part of the project development process. Long-term parking is currently allowed at MassDOT park and ride lots unless otherwise posted on-site. |
| | | | | Finally, my greatest concern as a resident is implementation. We can not afford to live in a regular state of gridlock as we currently do every time work needs to done on the bridge. Please remember that we live and work and go to school here and plan for this work accordingly. Thanks again for the opportunity to comment. Sincerely, Ellen Carlson | MassDOT is committed to ensuring mitigation of impacts and disruptions during construction of its projects to the extent possible, and a traffic management plan would be developed for any projects that move forward into implementation. |

| Date | Name: (First) | Name: (Last) | City or Town: | Comment: | MassDOT Response |
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| 6/20/2019 | Kristy | Senatori | Barnstable | Cape Cod Commission staff would like to thank the Massachusetts Department of Transportation (MassDOT) for its leadership in planning for mobility in the Cape Cod Canal area through the Cape Cod Canal Transportation Study. The project team, particularly project manager Ethan Britland, has been very open to listening to the concerns of the region and responding with a very in-depth analysis.<br><br>Safe and reliable transportation connections over the Cape Cod Canal are vital to the long-term vitality of the Cape Cod region and its people. Delays and poor travel time reliability hurt residents, businesses, and visitors through lost time, missed appointments, aggravation, pollution from auto emissions, and lead to a public perception that Cape Cod should be avoided because of traffic problems. These impacts and perceptions lead businesses to choose not to locate on Cape Cod and visitors to choose another travel destination. The overall impacts on the Cape's economy, while tough to quantify, is undeniable.<br><br>The recommendation of the MassDOT study, coupled with the finding that will come out of the United States Army Corps of Engineers Cape Cod Canal Bridges Major Rehabilitation Evaluation Study, will set the course for the future of the Canal area and the entire region.<br><br>Commission staff suggests that the MassDOT Cape Cod Canal Transportation Study Draft Report represents a comprehensive, multimodal analysis of transportation challenges in the Cape Cod Canal area. The traffic analysis and travel demand modeling take an in-depth look at the current and future transportation challenges in the region. The alternatives screening and evaluation processes are well-documented. The public process associated with the plan development was robust and allowed for open public dialog about the plan. | Thank you for your support and feedback. |
| | | | | Commission staff offer the following additional comments on the plan: The importance of continued coordination with the United States Army Corps of Engineers cannot be overstated. A comprehensive solution to the transportation challenges in the region can only be achieved is all parties effectively coordinate. | MassDOT will continue to work closely and collaboratively with our federal partners such as the USACE to ensure that both the bridges and adjacent infrastructure provide safe, efficient and multimodal mobility for the long-term, while also minimizing impacts to private right-of-way, environmental, cultural, and social resources. |
| | | | | Commission staff would encourage an expanded discussion on the potential for expanded public transportation options with specific recommendations on additional investments to support bus, rail, and ferry transportation options. Effectively utilizing all available modes of transportation presents the best long-term solution for the region. | MassDOT supports potential expanded public transportation options, and suggests that the Cape Cod Metropolitan Planning Organization's Regional Transportation Plan is the appropriate forum to advance this type of region-wide discussion. |
| | | | | Commission staff have been encouraged to see improvements proposed through the Transportation Improvement Program to address the significant safety issues on Route 6 (Scenic Highway) between the Bourne and Sagamore Bridges. Staff would encourage additional discussion of this segment of roadway in the plan with a recommendation for the installation of a raised median where one does not exist. | We will forward your request to MassDOT's District 5 office for more detailed discussions. |
| | | | | Commission staff suggest a review of Figures ES-6, 2-21, 2-22, 2-29, 2-30, 2-37, 4-36 and 4-37 for clarity and completeness of information. | The figures noted have been reviewed and revised, where applicable. |
| | | | | As recommended projects move into more advanced design phases Commission staff look forward to the opportunity to provide more detailed feedback. Commission staff look forward to working with MassDOT to advance, with additional public dialog, the recommendations of the plan that are in the best interest of the region.<br>Best Regards,<br>Kristy Senatori<br>Executive Director<br>Cape Cod Commission | As any recommendations move forward into project development, there will be additional public involvement opportunities. And we look forward to working with our local and regional partners on these very important recommendations. |

| Date | Name: (First) | Name: (Last) | City or Town: | Comment: | MassDOT Response |
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| 6/20/2019 | Steven | Tupper | Barnstable | I am writing to you on behalf of the Cape Cod Joint Transportation Committee (CCJTC), which includes representation from the fifteen towns of Barnstable County. The CCJTC thanks MassDOT for efforts in preparing the Cape Cod Canal Transportation Study draft report and looks forward to the implementation of solutions that improve the transportation system that serves the region. | Thank you for your support. |
| | | | | As much-needed, large-scale transportation improvements are considered in the Cape Cod Canal area, CCJTC would like to encourage MassDOT and other involved agencies to develop and implement a robust Traffic Management Plan (TMP). The TMP should acknowledge the regional impacts of construction activities and be sensitive of impacts to local trips within the towns of Bourne and Sandwich.<br><br>The TMP should follow industry best practices including innovative construction contracts, active traffic control plans, dynamic public information dissemination. Construction contracts should incentivize contractors to safely complete the project while minimizing the duration and magnitude of traffic impacts. Traffic control plans should anticipate network-wide impacts and be adaptable to unique traffic patterns on Cape Cod. Non-single-vehicle transportation options over the Canal, such as bus and rail, should be expanded upon during construction to minimize congestion. Finally, public information dissemination should be done in a comprehensive manner that allows the travelling public to plan accordingly for anticipated disruptions. | MassDOT is committed to ensuring mitigation of impacts and disruptions during construction of its projects to the extent possible, and a traffic management plan would be developed for any projects that move forward into implementation. This would include potential expansion of non-single-occupant-vehicle modes such as bus and rail, as well as a robust public information system. |
| | | | | The CCJTC looks forward to working with MassDOT and other agencies on the implementation of the recommendation in this plan.<br>Best Regards,<br>Steven Tupper<br>Transportation Program Manager, Cape Cod Commission<br>On behalf of the Cape Cod Joint Transportation Committee | We look forward to working with our local and regional partners on these very important recommendations. |
| 6/20/2019 | Stephen | Buckley | Chatham | Dear Mr. Britland,<br><br>Please see my comment below for the Draft Cape Cod Canal Study.<br><br>I realize that this may appear in a public document. Please do not redact any portion of it.<br><br>vr,<br>Stephen Buckley<br>OpenChatham.com<br>sbuckley714 (at) gmail.com<br>P: 508-348-9090<br><br>----------<br><br>OpenChatham (@OpenChatham) tweeted at 0:02 PM on Thu, Jun 20, 2019:<br><br>I can't find the public notice of "Request for Comment" (due 6/20), so I'm posting mine here:<br><br>Quality review of the Draft Study's recommendations is impossible because estimated Peak Traffic flow for a new Bourne Bridge (3x wider) is given, but *not* for a new Sagamore Bridge!<br><br>https://twitter.com/OpenChatham/status/1141737973840564224?s=03 | Thank you for your feedback. Projected volumes for all of the alternatives developed and analyzed as part of the study will be provided in the appendices. |

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| 6/26/2019 | Julian | Suso | Falmouth | The Town of Falmouth has carefully considered the elements of MassDOT's Cape Cod Canal Transportation Study. I am writing to confirm that at their regular business meeting of Monday, June 24th the Falmouth Board of Selectmen voted to submit this letter of support for the proposed improvements as outlined under the Case 3-A scenario. In the interest of public safety, it is further suggested that MassDOT closely collaborate with the US Army Corps of Engineers to jointly facilitate the replacement of both canal highway bridges in concert with the proposed improvements as expeditiously as possible. Thank you for the opportunity to provide a public response on behalf of the Town of Falmouth regarding this critically important transportation planning element. | Thank you for your feedback. MassDOT recognizes the importance of this vital transportation infrastructure to Cape Cod, the islands of Nantucket and Martha's Vineyard, and the Commonwealth. As you know, the Bourne and Sagamore Bridges are under the jurisdiction of the U.S. Army Corps of Engineers (USACE), which is currently conducting a study that will decide whether to replace its bridges or undertake major rehabilitation instead.<br><br>MassDOT will continue to work closely and collaboratively with our federal partners to ensure that both the bridges and adjacent infrastructure provide safe, efficient and multimodal mobility for the long-term, while also minimizing impacts to private right-of-way, environmental, cultural, and social resources. |